INDIAN AGRICULTURAL
RESEARCH INSTITUTE, NEW DELHI.

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19 MAR 1953

BULLETIN OF THE IMPERIAL INSTITUTE

A RECORD OF PROGRESS RELATING TO
AGRICULTURAL, MINERAL AND OTHER
INDUSTRIES, WITH SPECIAL REFERENCE TO
THE UTILISATION OF THE RAW MATERIALS
OF THE DOMINIONS, INDIA AND THE COLONIES

VOL. XL. 1942

36832

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IMPERIAL INSTITUTE, SOUTH KENSINGTON,
S.W.7

Library.

Printed in Great Britain by
A. Brown & Sons, Ltd., London and Hull.

BULLETIN OF THE IMPERIAL INSTITUTE

VOL. XL. 1942

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BULLETIN
OF THE IMPERIAL INSTITUTE

VOL. XL. NO. 1. JANUARY-MARCH, 1942

PLANT AND ANIMAL PRODUCTS

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Indian and Colonial Governments

LEPTOSPERMUM CITRATUM OIL FROM KENYA

In a previous issue of this Bulletin, 1931, **29**, 434, the results were published of the examination at the Imperial Institute of a sample of Australian *Leptospermum citratum* oil sent over by Mr. A. R. Penfold, Curator of the Technological Museum, Sydney. The oil had a strong lemon-like odour and was found to contain 73·5 per cent. (by weight) of aldehydes, consisting principally of citral and citronellal. It was considered that the oil would be of definite commercial value as a soap perfume, but would have to compete in the market with such oils as Cochin lemongrass oil and Java citronella oil.

Leptospermum citratum is a shrub or small tree, belonging to the natural order Myrtaceae, known locally as the lemon-scented tea tree. It occurs in the wild state at Copmanhurst, New South Wales, and at Springbrook and Palmwood, Queensland. It was soon recognised in Australia that if the oil was to be produced on a commercial scale, cultivation would be necessary, owing to its limited natural occurrence. Eminently successful results on the experimental cultivation of the tree in New South Wales, dating back to 1917, have been obtained by Mr. E. Cheel, Botanist and Curator of the National Herbarium, Sydney, and by Mr. Penfold, and experimental plantations, under both official and private auspices, have been established in various parts of the State. The question was also taken up by the Queensland Forest Service, which established a number of experimental plots throughout the State and also distributed young plants from its nursery at Beerwah, North Coast Line, Queensland A description of this work, with details of the oil obtained from the different experimental areas in both New South Wales and Queensland, and a discussion of the technical possibilities of the oil, is contained in "Australian Tea Trees of Economic Value, Part II," by A. R Penfold and F. R. Morrison, issued as *Bulletin* No 14, *Technological Museum*, Sydney, 1936.

This oil from the lemon-scented tea tree must be distinguished from that of another of the so-called tea trees of New South Wales, *Melaleuca alternifolia*, which contains from 50 to 60 per cent. of terpenes (pinene, terpinene and cymene), 3 to 8 per cent. of cineole and an alcohol, terpinenol This oil has valuable germicidal properties and is already in commerce, usually under the name " Ti-tree " oil.

In view of the fact that lemongrass and citronella grass do not thrive in Kenya, Mr Gilbert Walker, the well-known essential oil producer, of Nakuru, decided in 1936 to experiment with *Leptospermum citratum*, and he has very kindly furnished the Imperial Institute with particulars of his results. Fuller details are contained in a note prepared by him for publication in the *East African Agricultural Journal.*

Mr. Walker's farm is situated on the eastern side of the Great Rift Valley, at an altitude of 6,600 ft and possesses a light rather sandy soil. The first attempt, made at the end of 1936, to get the seed to germinate failed, but better success followed a further attempt in July of the next year The seed germinated in from 16 to 18 days, and five months later they were pricked out into boxes. At the end of another six months the plants were 6 to 8 in. high and ready to be transplanted. The plants were found to be delicate and slow in the early stages and very susceptible to damping off. Attempts to propagate by cuttings, from roots and by layering, were not a commercial success.

In order to study the growth of the trees the first few were planted in three rows of 75 trees each, spaced 5 ft. by 4 ft. The outer row was left untouched, the central row was used for experiments, and the third row for ordinary distillation. The central row was considered the most useful for obtaining data as nearly as possible under plantation conditions, but it is now overshadowed by the outer row which has grown to ten or twelve feet high and started flowering in 1940.

Growth after planting in June 1938 was rapid, and in December many trees were 2 ft high. In January 1939 the weight of leaf from an average tree was 6 oz., in April 9 oz., and in November, two years and four months after the sowing of the seed, the leaves and twigs of the 75 trees in the central row were gathered and weighed 204 lb. and the oil content was 1·7 per cent.

Fresh growth came on apace, and in July 1940, eight months later, a second cutting was made. The material weighed 420 lb., but the oil had fallen to 1·2 per cent.; this may have been partly due to the leaves being wet and heavy from a shower of rain and to the presence of a large number of young shoots, for it is known that mature leaves are the richest in oil.

In order to find out the effect of pruning back on the yield of leaf, blocks of 10 trees each were cut down to different heights from the ground, i.e. to 1 ft., 1 ft. 6 in., 2 ft., 2 ft. 6 in., and 3 ft., and allowed to grow for twelve months. In spite of an exceptionally long period of drought growth was good. In July 1941, a year after the cutting back, there was a new growth of 4 ft. throughout, when the leaves and twigs were cut. From the yields of green material obtained it was concluded that trees should not be pruned back to below 2 ft., although it might be best to cut them right back at least once in order to induce a shrubby growth, and perhaps this should be done at the time of planting out.

The weather throughout these trials was very dry, and it is noteworthy that five trees in the outer unpruned row died, presumably from drought, while the pruned trees did not suffer.

Meanwhile a plantation of six acres had been established in June 1939, and it has been considerably multiplied since then. In order to try and keep down weed growth and grass the trees were spaced 4 ft. by 4 ft. only.

The first commercial distillation was made in September 1940, when 371 lb. of oil were obtained from the six acres. This rather low result was not unexpected, when the inevitable misses are taken into account together with the unfavourably dry weather.

Another distillation from this same section in six months' time was disappointing; the mistake was made of harvesting before the new growth had matured. The very numerous young shoots are reddish in colour, and distillation should not be done at any rate before the general hue of the plantation has turned from a pink copper to a copper-green, and possibly even not for a long time after that. A recent first distillation from another section of plantation has produced 158 lb. of oil per acre.

Although the period between distillations must necessarily vary with the weather, the indications are that they should not be made at intervals of less than eight months, but it will take several years of study before reliable data on that and other kindred subjects are obtained.

In view of the labour costs involved in harvesting and distilling the fresh leaves and twigs it was decided to find out the effect of drying the leaf. A quantity of leaves and twigs were cut and a test showed an oil content of 1·44 per cent. Three hundred pounds of the material were then dried for three weeks in a galvanised iron-roofed building, and on distilling the yield of oil was found to be 1·46 per cent. expressed on the green material.

Another experiment was made later with sun-drying out of doors for five days. The original green material contained 1·68 per cent. of oil, while the yield from the sun-dried material was found to be 1·62 per cent. calculated on green basis. During the process of sun-drying the weight of leaves and twigs was reduced by 50 per cent., and the still was able to hold a larger charge of the dry leaf.

From this it appears that the leaf could be dried and stored until a sufficient quantity was ready to keep the stills working full time; it is not yet known whether the drying affects the percentage of aldehydes.

The yields of oil obtained in Kenya compare favourably with those recorded by Penfold and Morrison in the case of the Australian experimental areas.

In December 1939 Mr. Walker sent to the Imperial Institute a sample of oil distilled from leaves collected from bushes 2½ years old. The results of its examination are given below.

The sample was clear, light yellowish in colour, and possessed a strong odour of the lemon type.

An examination of the oil in the Imperial Institute laboratories gave the figures shown in the following table in comparison with the ranges of figures recorded in Australia for *Leptospermum citratum* oil by A. R. Penfold:

	Present Sample.	Australian *Leptospermum citratum* oil recorded by Penfold*
Specific gravity at 15·5°/15·5° C. .	0·8834	0·8792 to 0·8856
Optical rotation αD . . .	+4·33 at 21° C.	+3·5° to +5°
Refractive index nD20° C. . .	1·4736	1·4688 to 1·4757
Aldehydes, hydroxylamine method—expressed as citral and citronellal per cent.†	80·5	75 -- 85
Solubility in 70 per cent. alcohol (by volume) at 15·5° C. . . .	Soluble in 3·1 vols.	Soluble in 1 to 1·2 vols.

* *Bulletin No.* 14 *Technological Museum, Sydney,* 1936, "*Australian Tea Trees of Economic Value.*"

† *Method of the British Pharmacopoeia.*

These analytical results show that the present oil possesses constants which, except for solubility in alcohol, fall within the range indicated by Penfold for Australian *Leptospermum citratum* oil.

Portions of the sample were submitted to three firms of essential oil merchants in the United Kingdom who offered the following observations:

(*a*) "We have confirmed the constants given for this oil in the letter from the Imperial Institute dated March 16, 1940.

"The oil possesses a very good fresh note suggesting citral and citronellal which is due to the high content of these aldehydes.

"Its use would be in compounds for soap or lotions of the Eau de Cologne type. The oil would be in competition with the oils of lemongrass and Java citronella.

"To-day lemongrass oil is costing 2*s.* 10*d.* per lb., the rectified oil, say, at 3*s.* 6*d.* per lb., and Java citronella oil costs 2*s.* 6*d.* per lb.

"The market valuation of this oil of *Leptospermum citratum* we do not place higher than 3*s.* 6*d.*–4*s.* per lb. and its utility is along the lines suggested above (April 1940)."

(*b*) "The oil is certainly attractive, but whether it has any special merits as compared with the cheaper oils, such as lemongrass and the citronellas for soap making we cannot tell. We think, therefore, it would be unwise to encourage production unless it can compete with the above-mentioned oils. These oils are, as you know, to-day worth between 2*s.* and 3*s.* 6*d.* per lb (March 1940), but these prices are appreciably higher than those ruling before war broke out. If this oil can be produced and sold at round about 1*s.* per lb. we think experimental cultivation on a reasonable scale would be a fair risk and might prove profitable. Beyond this, however, we cannot venture to give an opinion."

(*c*) "We are interested in this particular oil and think it should be of considerable use to us if it can be produced at a price to enable it to compete in the ordinary way with Java citronella oil and lemongrass oil of commerce. We should be glad to have a much larger sample to enable us to make some very careful tests before giving a definite opinion on the value of the oil."

It will be noted that the market prospects and prices suggested for the oil by commercial firms differ somewhat. The oil is at present unknown in the trade in the United Kingdom, and its market value will be better known when the trade has had the opportunity of testing a consignment, but it seems unlikely that it would command a price much above that of Java citronella oil or that of Cochin lemongrass oil, the London spot prices of which before the war were from about 1*s.* 6*d.* to 2*s.* per lb. It is not considered that the oil could be usefully employed as a source of citral or citronellal, as these constituents are much more readily extracted from oils such as citronella or lemongrass in which they occur separately and not in admixture.

Mr. Walker informs the Imperial Institute that one of the firms whose report is quoted above ordered a trial consignment of the oil and 200 lb. has been sent to them. Another firm, in Australia, has ordered one ton of the oil at a satisfactory price. Mr. Walker considers that he has proved, at least under existing conditions, that a plantation of trees with a high yield of oil can be worked in competition with the quick-growing lower-yielding grasses in native hands in other countries.

ARTICLE

FUMIGATION BY SMOKES WITH SPECIAL REFERENCE TO DERRIS AND PYRETHRUM

A SURVEY OF RECENT LITERATURE

By S. T. P. BRIGHTWELL, M.Sc. (Lond.), D.I.C., A.R.C.S.,
Assistant, Plant and Animal Products Department, Imperial Institute

THE realisation of the need for protection of higher animals and plants against the lower animals, fungi and micro-organisms, has established the demand for protective agents applicable under all possible conditions. Fumigants, sprays and dusts—embracing gaseous, liquid and solid phases—each find their special application according to their individual merits, fumigants often possessing the advantage of better penetrating power though frequently limited in the concentration of toxic agents which can be set up. The cyanide fumigation of citrus trees against scale insects and the fumigation of ships, warehouses and dwelling houses, using hydrocyanic acid, sulphur dioxide, ethylene oxide and other substances, are notable instances of the successful application of the superior penetrating powers of fumigants. An even greater penetration may be secured by admitting the fumigant into the partially evacuated space to be treated.

Fumigants are classed in two groups—gases or vapours, and smokes or aerosols.[1] The former consist of vapours of the toxic agents alone or mixed with air or other inert gas, and the latter of suspended particles of liquid or dust in air, often stabilised as to their colloidal condition. The smokes offer the widest variety and also the highest concentrations of toxic agent available in the whole range of fumigants. However, besides the consideration of the toxicity and of the concentration of toxic agent, many fumigants are subject to grave fire hazard, so that the choice has often to be made between using a less inflammable material and the dilution of inflammable materials with inert substances such as carbon dioxide or carbon tetrachloride. Smokes, normally less inflammable than other fumigants, are now attracting some attention and appear to be regaining the place they occupied in very early times when incense smoke was employed for symbolic purposes, but doubtless valued for its hygienic functions.

In recent years the use of incense type smokes, especially as insectifuges, has increased, as shown by the following figures given for exports from Japan of solid insectifuge :—

---

[1] This term is used in the sense defined by Gibbs (*Clouds and Smokes*, 1924) as including all the various colloidal disperse systems in air.

Year	*Long tons.*	*Value in £ sterling.*
1930 . .	790	77,112
1935 .	1301	94,875
1939	1850	96,898

Such exportation is mainly to Oriental countries, and is probably largely a pyrethrum product. The manufactures are variously described [1], [2] and [3] as joss sticks, mosquito sticks and coils, "Russian batons," incense powders and cones, fumigating pastilles and papers, and "Papier-Russe." They consist essentially of a base, some gum, various aromatic constituents and often a specific disinfectant. The base is usually charcoal, an aromatic wood (sandalwood, cedarwood, rosewood or linden wood) or bran. The aromatic constituents are oils, balsams or resins and may include the gum to stiffen the mixture for moulding. Various specific disinfectants are used; for example, sulphur, camphor, trioxymethylene and pyrethrum. It is often necessary to add potassium nitrate (saltpetre) to ensure a steady burning, and occasionally alum is used when smouldering only is required. In a description of the preparation of Japanese mosquito sticks [4] the base mentioned is pyrethrum stalk powder, together with some pyrethrum flower powder and cinnamon leaves. Another description given by le Florentin [3] of Japanese anti-mosquito fumigants refers to the use of powdered pyrethrum seeds.

Besides any lethal action, smokes from these preparations possess certain useful properties as deterrents towards insects, and are particularly utilised against the mosquito as, for example, in mosquito coils. Baxter [5] recommends the burning of joss sticks and insect powder (pyrethrum) as a domestic measure for household protection against adult mosquitoes.

With such preparations it is difficult to know how much of the desired action is due to the specific agents added and how much to materials forming the base. Twort and Baker [6] have demonstrated the powerful germicidal action of burning cardboard and reports on the products of partial combustion of straw [3] indicate that the substances which distil from the straw are readily oxidised by catalytic action at the carbonised surface to aldehydic bodies—formaldehyde and trioxymethylene. The cellulose materials forming the base of incense preparations may, by careful incorporation, be made responsible for a significant part of the germicidal or insecticidal action. Goodhue and Sullivan [7], working with derris smokes, have indicated that more effective smokes are obtained when cornstalks, impregnated with rotenone, are burned than when the simple derris root is used. This increased toxic action may be due to the products of combustion of the corn stalk. The presence of carbonaceous particles from burning carbohydrates very much alters the properties of a fumigant [8], [9]. Aerosols of naphthalene tend to persist longer and give much smaller depositions in the presence of the smoke of burning cornstalks mixed with potassium nitrate. In addition, deposition was more even on all surfaces regardless of position. Similar effects were obtained when aerosols of orthodichlorobenzene were modified with the addition of lauric or oleic acids [9].

Various other factors have been demonstrated as affecting the efficacy of fumigant smokes. The importance of particle size has been stressed by Smith and Goodhue [10], in connection with mists and dusts, who found an optimum size to exist. The suspended particles of the smoke may be colloidal, microscopic, or even larger, though they often tend to a uniform stable size and may become colloidal on ageing. Very recently Baker and Twort [11] have reported that the relative humidity of the air in which the aerosol is formed is an exceedingly important consideration and largely determines the germicidal effects. This effect of humidity is to some extent paralleled by the behaviour of other fumigants [12], though often the effect is not great except in extreme variations of humidity.

In their work on the germicidal value of various aerosols Dr. C. C. Twort and co-workers [13], [14] used the flora of the saliva as test organisms and showed that the smoke from burning cardboard and incense was more toxic than that from tobacco and certain other substances investigated. Many complex phenols, when atomised by mechanical means or by heat gave smokes with very high toxicities. Their work has shown that much of the efficacy of these germicidal suspensions is dependent upon particle size and other physical properties which are able to control evaporation, and so the changes in size of the aerosol particles. In molecular dispersions the toxicity of the substances was significantly lowered. In this connection Smith and Goodhue [10] have noted that mists and dusts may be too finely dispersed for maximum efficiency. In addition, quite definite optimum concentrations of the active principles exist, and undoubtedly similar considerations will relate to the efficacy of other smokes and should be taken into account when their toxic values are assessed.

Various smokes have been in extended commercial use for some time, especially in glasshouses, when tobacco or materials impregnated with nicotine are often used to give smokes carrying the alkaloid nicotine. This alkaloid is volatile and moderately heat stable and has a considerable toxicity towards many types of insects, especially aphids. Using nicotine sulphate solutions vapourised by hot air, promising results were obtained in the control of codling moth on apple trees treated in the open [15] and [16]. Anabasine, an alkaloid allied to nicotine in insecticidal properties, has been considered as a fumigant but found to be less efficient than nicotine [17].

When pyrethrum and derris powders are burnt, mildly toxic smokes are formed [7], [18], [19], [20]. McIndoo and Sievers [18] reported that smokes from burning derris, cube and pyrethrum powders were toxic towards two species of aphid, *Macrosiphum* sp. and *Myzus persicae*. Goodhue and Sullivan [7] performed more elaborate experiments with the following results. Using the housefly (*Musca domestica* L.) as a test animal derris smoke at a concentration of less than 1 oz. of derris root per 1,000 cu. ft. gave a 50 per cent. kill. To produce an equal kill with pyrethrum smoke a dosage of 10 oz. per 1,000 cu. ft. was necessary. The susceptibilities of other insects were quite different ; the bean aphid (*Aphis rumicis* L.) was easily killed by derris smoke, but the cockroach (*Periplanata americana* L.) was little affected. The effect of pyrethrum smoke on the cockroach was quantitatively similar to that of pyrethrum smoke on the housefly. Simons [19] found that pyrethrum smoke had a rapid killing action on the mosquito but was slow in affecting the cockroach.

The interpretation of these results is that there are grounds for belief in the potency of smokes derived from burning derris and pyrethrum, but that, as Goodhue and Sullivan [7] point out, the exact procedure to be adopted for generating the smoke will influence its toxic value. When generated by simple burning it is very likely that only a small proportion of the initial material assumes the condition of a smoke. Twort and Baker [6] found that only 25 per cent. of the incense burnt is recoverable as smoke. Much of the material combusted becomes carbon dioxide and other comparatively harmless gaseous substances.

The active principles present in the smokes from derris and pyrethrum have received some attention. Goodhue and Sullivan [7] showed that a small amount of the initial rotenone content of the derris powder was present in the smoke—most of the rotenone is, however, destroyed during combustion. In the case of pyrethrum, the toxic agents present in the plant have been shown to be two complex esters, pyrethrins I and II [21], [22], and these substances are very easily destroyed by heat [23]. These active constituents are non-volatile and are probably completely destroyed during the combustion process. Further, the volatile part of pyrethrum flowers, which has been investigated by Merritt and West [24] and shown to be an essential oil, is without any toxic action towards honey bees [25]. It therefore seems probable that the toxic action of pyrethrum smoke is almost entirely due to products formed on combustion of the non-pyrethrin plant material. M. Nagasse, in a series of papers, has found that the smoke from burning pyrethrum powder contains neutral, phenolic, acidic and basic substances, the first predominating in amount as well as being the most toxic towards *Drosophila melanogasters* [26]. The following chemical substances were characterised—phenol, o-cresol [27], acet-, propion-, butyr- and isovaleraldehydes, and butyric and isovaleric acids [28]. Ripert [29] has already isolated from pyrethrum flowers besides the chrysanthemum acids, protocatechuic and isovaleric acids so that it is reasonable to conclude that the toxic constituents of pyrethrum smoke are derived from the non-pyrethrins present in the plant.

Although the available information is incomplete it is apparent that smokes from burning derris and pyrethrum powders are toxic to some insects, the former by virtue of some volatilised rotenone as well as by the decomposition products of the other constituents of the root and any additions made to the root powder. But the toxic action of pyrethrum smoke is almost entirely due to the products of combustion. The effect of these smokes can be improved by careful attention to the added substances and to the manner in which the smoke is formed.

A recent development in the technique of preparing certain aerosols has completely altered the position as regards derris and pyrethrum. The method, applicable to materials easily destroyed by heat, was described by Sullivan, Goodhue and Fales [9], [30]. A solution (in safrol or alcohol) of pyrethrum oleoresin or of rotenone is sprayed on a hotplate when a dense aerosol is formed having a toxic action equal to the smoke produced by the simple burning of amounts of pyrethrum or rotenone powders containing twenty times as much of the insecticidal principles. This fumigant was highly effective against houseflies and mosquitoes (*Culex* sp.), but had little or no action on the American cockroach. No carbonisation residue remained, and from the toxicity it seemed that very little of the active insecticidal constituents were lost during the dispersion. Mixtures of pyrethrum oleoresin and rotenone show toxicities greater than the sum of those due to the constituents when used singly. The rapidity with which an effective concentration of fumigant smoke is built up contributes to the increased toxicity. These authors have developed a compact apparatus which embodies fan, heater and distributor for carrying out the generation of these aerosols and the results already obtained suggest that by this method the range of materials that can be used as fumigants has been much extended, embracing not only possibly new substances but permitting the application of the old insecticides in new situations.

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NOTES

Sugar-Cane Wax.—The manufacture of sugar-cane wax as a by-product of the South African sugar industry, started at the time of the last war, was discontinued in 1930 as a result of competition from a number of other waxes which were being offered on the market at prices that made its production uneconomic. Under present war conditions it is possible that production may be resumed.

Meanwhile the possibilities of recovering sugar-cane wax in connection with the sugar industry of Louisiana are being investigated by the United States Department of Agriculture, which has in view the possibility of producing some 6 or 7 million pounds of the wax annually. The aim is, if possible, to obtain a product superior to the original Natal wax, which had some objectionable features such as a sticky feeling, a dark colour difficult to bleach, and sometimes an objectionable odour.

The wax occurs in a thin layer on the stalks of the cane, but the quantity is so small, amounting to less than 2 lb. per ton of cane, that its direct collection would not be economically possible, and the only practicable way of obtaining it is that employed in Natal, namely, recovery by means of solvents from the mud resulting from the clarification of the cane juice. The dried mud press-cake may contain from 5 to 17 per cent. of wax.

Research is being carried out in the United States with a view to ascertaining the most suitable solvents to use and the best conditions for obtaining a product having the desired qualities. Some of the undesired properties in the wax, it seems, are due to the fat which is present with it in the press-cake and has the effect of causing stickiness in the product, as well as of lowering its melting point. The fat is to some extent destroyed if the press-cake is allowed to undergo putrefactive fermentation before extraction, and it has been found that this procedure results in a harder wax. However, it appears likely that the disagreeable odour sometimes associated with the Natal product may have been due to this practice, and research in the United States is being directed to obtaining by other means a wax as free as possible from fat.

An account of the present position of the investigation is given in a report by R. T. Balch, an extract from which appears in *Industrial Reference Series, Part* 1, *Chemicals and Allied Products*, No. 76, October 1941, issued by the United States Department of Commerce. A number of solvents have been considered, and the suggestion is made that the solvent used should have a boiling point above the melting point of the wax. Toluene is regarded favourably and has been adopted for laboratory extraction. It is not one of the cheapest solvents, but cost is not of serious consequence, as the solvent can be recovered with only a low loss. Another point that is being investigated is the degree to which it is necessary to dry the press-cake before extraction, i.e. the proportion of moisture that can be left in it without impairing the efficiency of extraction, using various solvents. The removal of the fat associated with the wax is another problem, and results so far indicate that this can best be effected by a cold diffusion process using a " selective solvent," acetone being indicated as having the greatest possibilities taking into account initial cost and other considerations.

According to the publication mentioned it is proposed to set up a pilot plant at the Sugar Plant Field Station, Houma, Louisiana, in order to study the question on a scale approaching manufacturing conditions, and at the same time to provide a supply of wax for large-scale tests by prospective users.

Chrysil Rubber in the United States.—With the cessation of supplies of rubber from Malaya and the Netherlands East Indies, attention is once more being directed to the possibilities of producing rubber from the rabbit-brush, a shrubby plant occurring over vast areas in the arid regions of the Western States of America. According to the *Oil, Paint and Drug Reporter* for January 26, 1942, p. 43, scientists at the University of California have informed the United States Government that 500,000,000 lb. of naturally occurring rubber, sufficient to supply the country for five months, are ready for immediate harvesting.

Immediately after the entry of the United States into the last war an investigation was started under the auspices of the University of California and the Committee on Scientific Research of the State Council of Defence for California, for the purpose of locating a supply of rubber which was thought might exist in certain native West American shrubs. Fortunately, the stoppage of imports of rubber, which had been feared would result from enemy action, did not materialise, and the exploitation of native rubber was not necessary. Nevertheless, the investigation was continued beyond the duration of the war, and the results were published in full detail in "A Rubber Plant Survey of Western North America," by H. M. Hall and T. M. Goodspeed, issued as *University of California Publications in Botany*, Vol. 7, Nos. 6-7-8, pp. 159-278, Nov. 7, 1919.

Of the plants originally considered, species of *Chrysothamnus*, commonly known as rabbit-brush, seemed to be the most promising, and consequently they received the most attention. The results showed that rubber of good quality occurs in these latter plants, and if it could all be assembled from the existing wild plants, the quantity would be considerable,[1] although the percentage present in the plants is too small to warrant harvesting except under stress of national emergency. At the suggestion of Dr. F. E. Clements, the name "Chrysil" was adopted as the name for the rubber produced from these plants. The authors stated that "The very fact that the shrub is not rich in rubber may have its advantages when the matter is viewed from the standpoint of the nation's need. It means that the rubber will not be subjected to commercial exploitation and will thus be preserved as an emergency supply to be drawn upon only in case we reach such straits that its utilisation becomes necessary notwithstanding the high cost of harvesting." The position thus envisaged by the authors seems now to have been reached. As to the actual cost of production of Chrysil rubber the recent report submitted to the Government states that it should be possible to produce it for about 45 cents per lb., which is twice the nominal price of East India rubber in New York.

The genus *Chrysothamnus* comprises a considerable number of species of shrubs belonging to the *Aster* tribe of the Compositæ. Rubber has been found in several species, but the outstanding one is *C. nauseosus*, of which 22 varieties have been recognised and fully described by Hall in Part I of the Californian publication. Twelve of these varieties were examined and rubber found in all of them.

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[1] Hall and Goodspeed's original estimate was about 300,000,000 lb., but the latest estimate, as mentioned in para. 1, is much in excess of this.

The rubber-producing varieties are widely distributed in western North America, and range in altitude from sea-level in some of the desert basins to 8,000 ft. in the southern Colorado mountains. They reach their greatest development on somewhat moist, moderately alkaline soils, unsuitable for standard agricultural crops. The largest stands are in Colorada, Nevada and Utah. Plants found to have the highest rubber content were from Nevada and California.

The rubber occurs, not in latex tubes as in Hevea, but in individual cells as in the related Guayule plant (*Parthenium argentatum*) and like the latter Chrysil rubber would have to be extracted by a milling process The rubber is most abundant near the soil line and in harvesting the wild shrub it is suggested that the whole plant should be taken, including 4 in. of root; the young twigs should be removed as they contain very little rubber. If cultivation is taken up the plants would have to be cut so as to leave the base of the stem for regeneration.

The amount of rubber was found to vary with the botanical variety, the average percentage being 2·83 in var. *hololeucus*, 2·69 in var. *pinifolius*, 2·52 in var. *viridulus* (the commonest form in many areas) and 1·97 in var. *consimilis*. The highest percentage was 6·57 in a plant of var. *consimilis* and the next, 5·56 in a plant of var. *viridulus*.

A supply of *viridulus* shrub from California was supplied to Dr. D. Spence, Chairman of the Sub-committee on Rubber and Allied Substances of the National Research Council, who reported that the rubber he obtained from the material, although not as good as the best fine Para, was a great deal better than most African and low-grade rubbers.

Hall and Goodspeed strongly recommended that the cultivation of the rabbit-brush should be thoroughly investigated. They pointed out that although the wild plant only contains, on the average, about one-quarter of the amount of rubber found in wild guayule, it has many advantages over the latter. The individual plants are larger, averaging 6 lb. of rubber-carrying wood, as against ½ to 3 lb. in guayule; it is better adapted to the local conditions, one form growing over large areas where the temperature may fall to —20° F., whereas guayule needs a warm climate; it is very resistant to alkali and is thus suited to land too alkaline for any ordinary alkaline crop, guayule being sensitive to alkali; the water requirement is less; and, moreover, Chrysil rubber is stated to be superior to guayule and should realise a higher price and more nearly replace the fine imported rubbers.

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Annual Report of the Director of Forestry, State Forest Service, New Zealand, for the year ending March 31, 1941. Pp. 50, 13 × 8. (Wellington, N.Z.: Government Printer, 1941.) Price 1*s.* 3*d.*

Report on Forest Administration of Sierra Leone for 1940. Pp. 12, 9½ × 6. (Freetown: Government Printer, 1941.) Price 1*s.* 6*d.*

Forest Resources of the Upper Peninsula of Michigan. By R. N. Cunningham and H. G. White. *Misc. Publ. No.* 429, *U.S. Dep. Agric.* Pp. 32, 10½ × 8. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1941.) Price 20 cents.

Nursery Practice for Trees and Shrubs Suitable for Planting on the Prairie-Plains. By H. E. Engstrom and J. H. Stoeckeler. *Misc. Publ. No.* 434, *U.S. Dep. Agric.* Pp. 159, 9¼ × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1941.) Price 25 cents.

Nadere Gegevens over eenige Bemestingsproeven met Djata. By E. M. Drees. *Tectona,* 1940, **33,** 591-606. Further results of some manuring experiments with teak. With a summary in English.

Treatment of Teak (*Tectona grandis*) Plantations. By T. K. Mirchandani. *Indian For.,* 1941, **67,** 399-402.

The Cockchafer and Methods of Defence Against It. By L. Ossowski. *Quart. J. For.,* 1941, **35,** 147-150.

Investigations on the Biology of *Euproctis terminalis* Walk., the Pine Brown Tail Moth and its Control by Aeroplane and Ground Dusting. By F. G. C. Tooke. *Sci. Bull. No.* 179, *Dep. Agric. Un. S. Afr.* Pp. 48, 9½ × 6. (Pretoria: Government Printer, 1938.) Price 3*d.*

Timber

The Principal Timbers of Jamaica. By C. Swabey. *Bull. No.* 29, *Dep. Sci. Agric. Jamaica.* Pp. 37, 9¾ × 6. (Kingston, Jamaica: Government Printer, 1941.)

The Properties of Australian Timbers. Yellow Carabeen (*Sloanea woollsii* F.v.M.). *Mthly News Lett. No.* 117, 1941, *Coun. Sci. Industr. Res. Aust.,* p. 3.

Some Physical Properties of Modern Cabinet Woods. 1. Hardness. By E. S. Harrar. *Trop. Woods,* 1941, No. 68, 1-11.

The Uses of Timber. Rifle Furniture. *Mthly. News Lett. No.* 117, 1941, *Coun. Sci. Industr. Res. Aust.,* p. 4.

Indian Timbers for Tool Helves and Handles. By D. Limaye. *For. Bull. No.* 93, *For. Res. Inst., India.* Pp. 8, 9¾ × 7½. (Delhi: Manager of Publications, 1941.) Price As. 5.

Gums and Resins

De Agathisbosschen in de Afdeeling Poso. By A. P. Van der Vlies. *Tectona,* 1940, **33,** 616-640. Proposals for improving methods of collecting copal from *Agathis* spp. in Celebes.

Reducing the Acidity of Manila Copal. Reaction of Run Copal and Glycerol. By G. D. Manalo and A. P. West. *Philipp. J. Sci.,* 1941, **75,** 233-243.

Annual Report of the Indian Lac Research Institute, India, for 1940-41. Pp. 41, 9½ × 7½. (Nankum, Bihar: Indian Lac Research Institute, 1941.)

Tanning Materials

Tannin Content of Sitka Spruce Bark. R. W. Frey. *J. Amer. Leath. Chem. Assoc.,* 1941, **36,** 576-584.

Wattle Bagworm (*Acanthopsyche junodi*) Control by Aeroplane Dusting. By T. J. Naudé, L. B. Ripley and B. K. Petty. *Sci. Bull. No.* 206, *Dep. Agric. Un. S. Afr.* Pp. 12, 9½ × 6. (Pretoria: Government Printer, 1939.) Price 3*d.*

IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 17

(October to December 1941)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

GENERAL

New Insecticide Regulations. New Regulations for Enforcement of the Insecticide Act of 1910 just issued by the U.S. Agricultural Marketing Service. *Soap*, 1941, **17**, No. 10, 111-113.

Agricultural Insecticides. A Brief Summary of Findings and Recommendations on Agricultural Pest Control Problems—as reported by State Agricultural Experiment Stations, U.S.A. *Soap*, 1941, **17**, No. 11, 97-105. References to rotenone and derris as being most promising toxic materials for addition to oil sprays; a combined rotenone-sulphur dust to control turnip louse and cabbage looper; superiority of nicotine or rotenone over pyrethrum for controlling onion thrips; effectiveness of derris against onion thrips improved by addition of talc or clay; nicotine if toxic to an insect is nearly equally toxic regardless of the form in which it is administered; vegetable and animal oils, notably castor oil and pine oil, more efficient carriers of nicotine than petroleum oil; deposits resulting from nicotine compounds; control of lygus bug on alfalfa with pyrethrum; rotenone and pyrethrum as standard sprays for control of cranberry insect pests; pea weevil control by rotenone or cube; elasticity of films of soybean oil and peanut oil used as stickers; use of rotenone in conjunction with calcium arsenate for boll weevil control.

Annual Report of the East Malling Research Station, Maidstone, Kent, for 1940; p. 14 refers to routine sprayings on the experimental farm with nicotine, rotenone and derris; also confirms that mineral oil sprays with nicotine show no improvement on nicotine and soft soap.

Flies for the Peet-Grady Test. By W. A. L. David and G. L. Harvey. *Soap*, 1941, **17**, No. 10, 103-105. Describes an apparatus for separating fly pupæ from the culture medium in rearing flies for use in the Peet-Grady chamber.

Variation in Peet-Grady Tests. Study of Effects of Using Reduced Dosage and Reduced Time Exposure in the Peet-Grady Test. By J. H. Ford. *Soap*, 1941, **17**, No. 11, 91-96, 107. Tests carried out with two finished sprays one containing pyrethrum and the other pyrethrins and rotenone.

Controlling Bot and Warble Flies of Livestock in Missouri. By L. Haseman and W. E. Roland. *Bull. No.* 430, 1941, *Missouri Agric. Exp. Sta.* Refers to the use of derris for the treatment of grubs of the warble fly (pp. 27-28) and mentions the excellent results obtained also with pyrethrum and nicotine.

A Preliminary Report on Control of the Western Twelve-Spotted Cucumber Beetle in Orchards. By A. E. Michelbacher, G. F. MacLeod and R. F. Smith. *J. Econ. Ent.*, 1941, **34**, No. 5, 709-716. Pyrethrum and rotenone tested.

Control Insecticide Exports. *Soap*, 1941, **17**, No. 8, 125. Insecticide materials including pyrethrum, cube (timbo or barbasco), derris, rotenone and red squill subjected to export control in United States.

Alabama Exp. Sta. Rep., 1939 (abstract in *Exp. Sta. Rec.*, 1941, **85**, 499). References to the relative efficiency of rotenone-containing insecticides for the control of a number of insects attacking vegetables, and derris as a toxic supplement to oil emulsion for purple scale control.

Results of Tests for the Control of the Pea Aphid (*Macrosiphum onobrychis*) in Eastern Virginia. By H. G. Walker and L. D. Anderson. *Trans. Peninsular Hort. Soc.*, 1940, 30-35. (*R.A.E.*, 1941, **29**, A, Pt. 10, 504.) Dusts containing derris or cube with talc gave very variable results and nicotine dusts good results when properly applied; derris sprays gave good results; atomised oils containing rotenone or nicotine unsatisfactory results owing to difficulty of getting adequate coverage.

Cotton Jassids and Their Control. By K. B. Lal. *Indian Frmg.*, 1941, **2**, 465-468. Mentions the effectiveness of pyrethrum sprays and nicotine dusts.

Factorial Studies on Potato Dusting Materials. By J. B. Skaptason and F. M. Blodgett. *Amer. Potato J.*, 1941, **18**, No. 1, 1-9. (Abstract in *Exp. Sta. Rec.*, 1941, **85**, 643.) Further experiments confirm earlier findings that a " 3-way " dust consisting of rotenone, pyrethrum and sulphur give increased potato yields. Pyrethrum caused a significant decrease in leaf hoppers.

Orchard Insects of the Pacific Northwest and Their Control. By E. J. Newcomer. *Circ. No.* 2700 (*Revised*), 1941, *U.S. Dep. Agric.* Discusses the values of nicotine, pyrethrum and rotenone, pp. 73-74.

Het landbouwkundig onderzoek bij overjarige cultures, in het bijzonder bij eenige nieuwe handelsgewassen. By W. K. Huiteme. *Bergcultures*, 1941, **15**, No. 25, 820-822. Refers to experimental work with derris and pyrethrum as crops for the Netherlands East Indies.

Verslag van de commissie van advies inzake de bevordering van de cultuur van handelsgewassen over het jaar 1940. *Bergcultures*, 1941, **15**, No. 32, 1093-1094. Gives particulars of the production of derris in the Netherlands East Indies and of the experimental production of pyrethrum; also mentions that cube might be worth trials.

Control of Codling Moth with Arsenate of Lead and Certain Forms of Rotenone and Pyrethrum. By B. G. Pratt. *J. Econ. Ent.*, 1941, **34**, No. 3, 424-426. Describes the results obtained with a new oily base or carrier for rotenone and pyrethrum which increases their activity against the codling moth and permits their use with the milder alkaline sprays, such as lime sulphur, flotation sulphur, etc.

Field Trials with Two New Insecticides. By R. W. Roth and L. Pyenson. *J. Econ. Ent.*, 1941, **34**, No. 3, 474. Compares the effectiveness of mannitan monolaurate alone and in conjunction with rotenone and pyrethrum against the green apple aphid and the corn earworm.

Density and Flowability of Insecticidal and Fungicidal Dusts and Dust Ingredients. By J. D. Wilson and M. A. Vogel. *Bull. No.* 209, 1941, *Ohio Exp. Sta.* Abstract in *Exp. Sta. Rec.*, 1941, **85**, No. 4, 489.

A Study of Correlation between Repellency and Natural Evaporation of Common Livestock Spray Base Oils. *Soap*, 1941, **17**, No. 10, 107-109.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Ann. Rep. Agric. Res. Scheme, Indian Cent. Jute Comm. for 1939-40. (*R.A.E.*, 1941, **29**, A, Pt. 9, 446-447.) Spraying with nicotine sulphate was effective against the young larvæ of *Anomis sabulifera* Gn. attacking jute.

Toxicological Studies with Adults of Apple Maggot and Cherry Fruitflies. W. W. Middlekauff and R. Hansberry. *J. Econ. Ent.*, 1941, **34**, No. 5, 625-630. Nicotine products tested.

Characteristics of Different Types of Nicotine Sprays. I. Nicotine Residues. By L. B. Norton and O. B. Billings. *J. Econ. Ent.*, 1941, **34**, No. 5, 630-635.

Characteristics of Different Types of Nicotine Sprays. II. Codling Moth Control. By R. Hansberry. *J. Econ. Ent.*, 1941, **34**, No. 5, 636-638.

Advice on Codling Moth Control. *Farmer, S. Afr.*, 1941, **30**, No. 47, 8. Refers to use of nicotine.

Apple Aphids. *Adv. Leafl. No.* 106, *Minist. Agric. Lond.* Nicotine and soap spray recommended for control.

Apple Leaf Hopper. *N Z. J. Agric.*, 1941, **63**, 337. Nicotine sulphate recommended for use against this pest in New Zealand.

Mineral Oil Emulsions Against the Apple-tree Moth. By G. Shurovenkov. *Sady i Ogorody* (*U.S.S.R.*), 1941, No. 3, 40-41. (Abstract in *Amer. Chem. Abst.*, 1941, **35**, 7100.) Spraying with anabasine sulphate and liquid soap during appearance of beetles followed by a second spraying with internal insecticides.

Un nuevo enemigo de los manzanos en la Argentina, *Typhlocyba froggatti* Baker. By J. R. Christensen. *Rev. Soc. Ent. Argent.*, 1940, **10**, No. 3, 298-301. (*R.A.E.*, 1941, **29**, A, Pt. 10, 496-497.) Describes a new pest of apples in the Argentine, which it is suggested could be controlled by a nicotine spray.

Codling Moth Control in Apples. By W. A. K. Stubbings. *Frmg. S. Afr.*, 1941, **16**, 379. Fixed nicotine with oil sprays tends to replace lead arsenate in the spray programme in South Africa.

Codling Moth Control in Pears. Suggested Spray Programmes for the 1941-42 Fruit Season. By R. I. Nel and W. A. K. Stubbings. *Frmg. S. Afr.*, 1941, **16**, 391-392. Recommends the use of fixed nicotine and oil emulsions at certain stages.

Control of the Pear Psylla in Connecticut. *Circ. No.* 143, 1941, *Conn. Agric. Exp. Sta.* (*R.A.E.*, 1941, **29**, A, Pt. 11, 533-534.) Use of nicotine sulphate with white summer oil spray recommended.

The Control of Fruit Tree Red Spider Mite (*Oligonychus ulmi* Koch). By H. G. H. Kearns and H. Martin. *J. Bath W.S. Co. Assoc.*, 1939-40, **14**, 90. (Abst. in *Amer. Chem. Abst.*, 1941, **35**, 8191.) A suitable petal-fall contact spray contains nicotine ; when control of plum sawfly also necessary, oil-emulsion and rotenone recommended.

Preliminary Experiments on the Control of the Holly Leaf Miner. By A. Hartzell and G. F. McKenna. *Contrib. Boyce Thompson Inst.*, 1941, **12**, 119-126. (Abst. in *Amer. Chem. Abst.*, 1941, **35**, 7101.) An effective spray consists of nicotine sulphate and fish oil.

Some Delphinium Pests. By G. F. Wilson. *Delphinium Yearbk.*, 1941, 7-9. (*R.A.E.*, 1941, **29**, A, Pt. 9, 448.) The larvæ of *Plusia moneta* controlled by dusting with nicotine.

Nicotine Products Developments. *Chem. Tr. J.*, 1941, **109**, 320. Note on production of nicotine in the U.S.A. and on the consumption for insecticidal purposes.

Other Alkaloid-containing Materials

Preliminary Experiments on the Insecticidal Value of Certain Plant Extracts, more particularly those of *Delphinium brownii* Rydberg. By H. T. Stultz and N. A. Patterson. *Sci. Agric.*, 1941, **21**, 776-782. (Abst. in *Amer. Chem. Abst.*, 1941, **35**, 7634.) Alkaloid of this plant promising as a contact insecticide but cannot be expected to excel nicotine sulphate.

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

The Rise of Rotenone. By R. C. Roark. *Agric. in Americas*, 1941, **1**, No. 8, 11-14.

Present Status of Rotenone and Rotenoids. By R. C. Roark. *J. Econ. Ent.*, 1941, **34**, No. 5, 684-692.

Rotenone in Red Scale Control. *Soap*, 1941, **17**, No. 8, 125. Increased killing power on red scale in citrus groves said to result when rotenone added to an oil spray.

A Progress Report on Tomato Fruit Worm Studies. By J. G. Watts. *J. Econ. Ent.*, 1941, **34**, No. 3, 400-405. Among a number of insecticides tested (chiefly arsenates) rotenone was the only one which gave no control.

Derris

Report on Agriculture in Malaya for 1940, p. 6. Brief reference to derris spacing experiments in progress.

Annual Report of the Ontario Agricultural College and Experimental Farm, Department of Agriculture, for 1940, p. 61. Spraying with derris (1 per cent. rotenone) and synthetic cryolite proved satisfactory for the control of the borer on sweet corn.

Derris Root Infusion for Psoroptic Scabies in Horses and Carabaos. *Philipp. J. Anim. Indust.*, 1941, **7**, 409-418. (Abst. in *Vet. Bull.*, 1941, **11**, No. 8, 558.)

Derris Root Infusion as a Tickicide for Cattle and Horses. By R. B. Gapuz. *Philipp. J. Anim. Indust.*, 1941, **7**, 431-437. (Abst. in *Vet. Bull.*, 1941, **11**, No. 8, 558.)

The Control of Human Lice under War Conditions. *Canad. Ent.*, 1941 **73**, No. 1, 20. (*R.A.E.*, 1941, **29**, B, Pt. 9, 143.) Use of (*a*) derris powder and (*b*) lavender oil satisfactory.

Concentrations of Derris Sprays Effective on the Imported Cabbage Worm. By L. Pyenson and R. W. Roth. *J. Econ. Ent.*, 1941, **34**, No. 3, 473-474.

Co-operative Japanese Beetle Work in Maryland. By G. S. Langford, F. B. Whittington, R. H. Vincent and E. N. Cory. *J. Econ. Ent.*, 1941, **34**, No. 3, 416-418. Derris or rotenone dust, with a good sticker, was the most efficient of the non-poisonous materials tested for the control of this pest.

Stuiven en spuiten met Derris tegen de vlasthrips in Nederland. By W. Spoon. *Bergcultures*, 1941, **15**, 1020-1023. Dusting and spraying with derris against thrips of flax in Holland.

Ann Rep. Ontario Agric. Coll., 1940, p. 61. Reference to spraying sweet corn, for the control of corn borer (*Pyrausta nubilalis*), with derris and synthetic cryolite; gave promising results.

Raiz de Derris y otras plantas insecticidas utiles e importantes para su cultivo en Guatemala. Pt. 3. By F. Ippisch. *Rev. Agricola Guatemala*, 1941, 18, 86-89. Cultivation of derris and sampling of roots.

Some Laboratory Tests with Oil Emulsions Against Wheat Weevil *Calandra oryzæ*. By H. G. Andrewartha. *J. Dep. Agric. S. Aust.*, 1941, **44**, No. 6, 307-308. (*R.A.E.*, 1941, **29**, A, Pt. 11, 540.) A number of chemicals and derris were tested but found ineffective or too expensive.

Others

Compatibility of Bordeaux Mixture and Cube. By R. A. Fulton and R. H. Nelson. *J. Econ. Ent.*, 1941, **34**, No. 5, 647-649.

Summary of the Scientific Research Work of the Institute of Plant Protection, Lenin Academy of Agricultural Science, Leningrad, for 1939. The Investigation of Pyrethrum Extracts and New Vegetative Poisons. By G. V. Blyumberg. Pp. 143-145. (*R.A.E.*, 1941, **29**, A, Pt. 11, 586.) Disucsses the most suitable solvents for extracting the active principles from introduced species of Tephrosia.

PYRETHRIN-CONTAINING MATERIALS

Belgian Congo Plants Pyrethrum. *Foreign Crops and Markets, U.S. Dep. Agric.*, 1941, **43,** No. 3, 67. Particulars of plantings and of a Government ordinance designed to keep the quality of the product high.

Belgian Congo Pyrethrum. *Anglo-Belg. Tr. J.*, 1941, **28,** No. 1, 10. Note on the formation of an " Office de Pyrèthre " at Costermanville whose object is to conduct research with a view to increasing the output, standardising the quality of pyrethrum and promoting trade.

Brazilian Production Increases of Pyrethrum Flowers. *Foreign Crops and Markets, U.S. Dep. Agric.*, 1941, **42,** No. 19, 700-701. Gives particulars of the estimated production for 1938, 1939, 1940 and a preliminary forecast for 1941.

Italian Government Encourages Planting of Pyrethrum. *Foreign Crops and Markets, U.S. Dep. Agric.*, 1941, **43,** No. 2, 44.

Pyrethrum in Kashmir. By M. R. Fotidar. *Indian Frmg.*, 1941, **2,** 413-415. Notes on cultivation, etc.

Pyrethrum. *Indian East. Chem.*, 1940, 21, 23. (Abst. in *J. Amer. Pharm. Assoc., Sci. Ed.*, 1941, **30,** No. 8, 228.) Relates to experiments on cultivation of pyrethrum laid down by the Bureau of Agriculture of the Netherlands East Indies in Central Java.

Ohio State Pyrethrum Study. *Soap*, 1941, **17,** No. 11, 111. Co-operative projects with Kenya Farmers' Association (Co-operative) Ltd., through Kenya Pyrethrum Extension Service in New York.

The Toxic Effect of Pyrethrum and Aliphatic Thiocyanate upon the Eggs and Larvæ of *Ephestia elutella* and the Adults of *Sitophilus oryzæ* and *Bruchus chinensis*. *Ent. Mem. Dep. Agric., Un. S. Afr.*, 1940, **2,** Pt. 4, 41-51. (*R.A.E.*, 1941, **29,** A, Pt. 9, 434-435.)

Pyrethrum for Corn Worm. *Soap*, 1941, **17,** No. 8, 129. Involves the use of a highly refined mineral oil containing 0·2 per cent. pyrethrins, applied to the ears individually using a special plunger type oil can.

Action of Pyrethrum on Mosquito Larvæ. By R. N. Chopra, D. N. Roy and S. M. Ghosh. *J. Malar. Inst. India*, 1940, **3,** No. 4, 457-463. (*R.A.E.*, 1941, **29,** B, Pt. 9, 148.)

Pyrethrum as Larvicide. *Soap*, 1941, **17,** No. 10, 113.

Study of Two Types of Pyrethrum. By N. S. da Cunha. *Trib. Farm., Parana*, 1939, **7,** 199. (Abst. in *J. Amer. Pharm. Assoc., Sci. Ed.*, 1941, **30,** No. 9, 259.) *Anacyclus pyrethrum* (L.) de Candolle often confused with the insecticide pyrethrum ; photo-micrographs show the cellular structures differentiating the roots.

Effects of Pyrethrins on Blowflies. By L. D. Anderson and R. A. Hook. *J. Econ. Ent.*, 1941, **34,** No. 5, 725-726.

Interrelation of Pyrethrins. *Soap*, 1941, **17,** No. 10, 113.

Dermatitis caused by Insecticidal Pyrethrum Flowers (*Chrysanthemum cinerariifolium*). By J. T. Martin and K. H. C. Hester. *Brit. J. Derm.*, 1941, **53,** 127-142. (*R.A.E.*, 1941, **29,** A, Pt. 10, 527-528.)

Summary of the Scientific Research Work of the Institute of Plant Protection, Lenin Academy of Agricultural Science, Leningrad, for 1939. The Results of Field Tests of Pyrethrum as a Control Measure against Pests. By I. V. Nikitin. Pp. 140-143. The Investigation of Pyrethrum Extracts and New Vegetative Poisons. By G. V. Blyumberg. Pp. 143-145. (*R.A.E.*, 1941, **29,** A, Pt. 11, 585, 586.) An account is given of work on the extraction of pyrethrins from the green parts of the pyrethrum plant.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Verslag van de commissie van advies inzake de bevordering van de cultuur van handelsgewassen over het jaar 1940. *Bergcultures*, 1941, **15,** No. 32, 1096. Note with regard to the insecticidal properties of powdered seeds of *Pachyrrhizus erosus* Urban.

Blumea densiflora and *Artemisia vulgaris*: their Insecticidal and Larvicidal Properties. By R. N. Chopra, D. N. Roy and S. M. Ghosh. *J. Malar. Inst. India*, 1940, **3**, No. 4, 495-498. (*R. A.E.*, 1941, **29**, B, Pt. 9, 150.)

Insect-repellent Action of Extracts of the Leaves of *Melia azedarach*. By M. Volkonsky. *Arch. Inst. Pasteur Algerie*, 1937, 427-432. (Abst. in *Amer. Chem. Abst.*, 1941, **35**, 7104-7105.)

A Survey of Plant Products for Insecticidal Properties. By A. Hartzell and F. Wilcoxon. *Contrib. Boyce Thompson Inst.*, 1941, **12**, 127-141. (Abst. in *Amer. Chem. Abst.*, 1941, **35**, 7105.) Products of a number of botanical drugs gave kills of 90-100 per cent. to mosquito larvæ; a steam distillate of elecampane effective on *Aphis rumicis*.

BOOK REVIEWS

Books for review should be addressed to " The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

FUNDAMENTALS OF LEATHER SCIENCE. By D. Woodroffe, M.Sc., A.I.C. Pp. 158. (Croydon: A. Harvey, 1941.) Price 8*s.* 6*d.*

This small book is designed to provide a concise summary of the scientific principles involved in the various processes which are concerned in the conversion of raw hide to leather, and particularly the results of the combined work of chemist, physicist and biologist during the past twenty years, in which considerable advance has been made in understanding the tanning process as a result of accurate scientific observation.

The task has been well done, and the book must be considered a highly satisfactory companion to those larger text books which are mainly devoted to details of tannery practice. A valuable feature of the work is the bibliography; at the end of each chapter is an up-to-date list of references to original papers and authoritative works on the subject.

In the Introduction, which forms Chapter I, an outline is given of the operations necessary for the production of a finished leather from the raw hide or skin, and which are dealt with in the chapters that follow. The constitution and chemical composition of the raw skin are discussed, and the changes which take place during the various processes to which it is subjected in the tannery. These include soaking, liming, puering, bating and drenching. Vegetable, chrome and miscellaneous tanning processes such as alum, oil, formaldehyde, quinone and silica tannages, as well as the use of synthetic tanning are covered in appropriate chapters.

The scientific side of fat-liquoring, currying, dyeing and finishing, and the nature of pigment and cellulose finishes are briefly stated.

Mr. Woodroffe's book is a very convenient survey of modern views on leather chemistry, and happily shows that, to a rapidly increasing degree, the tanning process can be expressed in terms which have a scientific meaning.

THE EXTRA PHARMACOPOEIA OF MARTINDALE. Volume I. Pp. xxxviii + 1289, 7 × 4½. Twenty-second Edition. Published by direction of the Council of the Pharmaceutical Society of Great Britain. (London: The Pharmaceutical Press, 1941.) Price 27*s.* 6*d.*

The Revision Committee, the Editor and his assistants are to be congratulated on this new edition of Martindale, brought out under all the difficulties of war time. To get together all the latest information on the development of pharmacy and therapeutics and compress it within reasonable limits must have been a huge task. Nearly sixty per cent. of the matter has had to be reset for this edition and of this reset material by far the larger proportion is new to the book. To avoid having to delete too much of the last edition to make room for the new matter, the use of small type has been increased. Even so, the present volume is over 100 pages larger than its predecessor.

This new edition will not only be of the greatest use to British pharmacists and medical men, but will be of special value to the many medical men and scientists from every country of Europe now finding asylum here, to say nothing of the many American doctors who are entering the medical services of Great Britain in these times.

INSECT PESTS OF STORED GRAIN AND GRAIN PRODUCTS. By Richard T. Cotton. Pp. 242, 9 × 5½. Multigraphed. (Burgess Publishing Company, 426 South Sixth Street, Minneapolis, Minn., 1941.) Price $3.00 (cash, in U.S. funds, with order).

The author of this book is Senior Entomologist in the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture and the information contained in it is both up to date and authoritative. The first 48 pages are devoted to the insects and mites associated with grain and flour, and include well-illustrated accounts of the various pests and the damage they cause. The remainder of the book is concerned with methods of control at the different stages of handling the grain and its products, e.g. on the farm, in elevators and warehouses, in flour mills, and after manufacture (in stores and the home). The many different kinds of fumigants that are used or have been proposed are discussed and the methods of fumigation employed in ordinary buildings and in special atmospheric vaults and vacuum chambers are described. A chapter is also devoted to heat sterilisation in the flour mill. Numerous references to literature are given at the end of each chapter.

It will be seen that every aspect of this important subject is covered and being essentially a practical book it should be of great value to all concerned in the storage of grain and flour.

GOLD COAST TIMBERS. Edited by the Chief Conservator of Forests, Captain R. C. Marshall, B.Sc., M.A., Dip. For. Pp. viii +45, 8½ × 5½. (Gold Coast: Government Printer, 1941.) Price 1*s*. 6*d*.

This little book has been compiled by officers of the Gold Coast Forest Service and describes briefly 44 different timbers, of which 20 are sufficiently well known in commerce to bear the standard trade names of the British Standards Institution. The treatment is uniform throughout. The timbers are arranged under the natural order to which the tree belongs, but reference is facilitated by two indexes, one to the botanical names and the second to the standard and local trade names and other common names. In each case the size of the tree is given and its distribution and frequency. The character of the wood is described, its durability, degree to which it is impregnated with preservatives by the open-tank method, the time it takes to season (determined on 1 in. planks at Takoradi), working qualities, uses, and the quantity available. Data on mechanical properties are not given, but these are to be found in some cases in the Forest Products Research Laboratory's handbook on *Empire Timbers*. Further information on this latter point, as well as in other directions, can be had on application to the Chief Conservator of Forests, Accra.

This book is very timely as it serves to draw attention to a number of timbers which can be obtained from the Gold Coast to replace those which are now scarce or to meet the increased demand brought about by war-time conditions.

MINERAL RESOURCES

ARTICLE

THE GEOLOGY OF THE KONONGO GOLD BELT AND SURROUNDING COUNTRY

By T. Hirst, D.I.C., A.R.C.S., A.Inst.M.M.
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Introduction

The Konongo Gold Belt, in the Ashanti-Akim district of Ashanti, lies at the north-eastern extremity of the great gold channel, which stretches in a direction a little north of north-east from far to the south-west of Prestea to the Voltaian escarpment, and on which are situated all the large gold-quartz mines of the Gold Coast, with the exception of Bibiani. In the larger sense, the Konongo belt may be said to extend from the neighbourhood of Lake Bosumtwi, a distance of some 23 miles to near Domiabra, 5 miles south of the Voltaian escarpment. Konongo mine, roughly in the centre of the belt, is some 34 miles from Kumasi by road and is within a mile or so of Konongo station on the Accra-Kumasi section of the Gold Coast Railway (see Key Plan on map).

Active prospecting of various parts of the belt was resuscitated in 1933 and carried on almost to the outbreak of war. Little success was met with in the area between Odumasi and Lake Bosumtwi, however, and for this reason, and also because of the limited time available, this section was not included in the area mapped by the writer. All the more promising prospects are within the area covered by Gold Coast Survey 1 in. sheet Bompata S.E., and the whole of this sheet, which extends many miles east of the gold belt, was mapped, together with about a third of the sheet Bompata N.E., which includes the boundary between the Voltaian and the older rocks. In all, some 400 sq. miles were mapped, and underground and surface investigations of mines and prospects made, from January to March 1939, and January to March 1940. At the outbreak of war, Lyndhurst Deep Level, Ltd., and Nanwa Gold Mines, Ltd., neither of which had commenced production, suspended development operations, and consequently the writer had no opportunity of seeing the latest developments at the Boabedroo and Obenemasi mines. These are the most important prospects apart from Konongo mine itself. Although no prospecting is being done at present in the belt most of these operations have been inspected by the writer at various periods in the past few years.

Previous work in the area by the Geological Survey includes traverses by Teale, Whitelaw, Junner and the writer. In 1924 Teale made a detailed examination of the gold belt from the railway at Odumasi, near Konongo, to Domiabra.[1] He also investigated deposits of manganese rock which had been noted by him in 1918 on Brinsem (Birinsim) hill east of Chichibiasi, and by Kitson and Cooper in 1922 on the railway near Odumasi. He recognised, in the area examined by him, two zones of greenstones and schists (now classified as Upper Birrimian) separated by a zone of arenaceous sediments (Tarkwaian), and described old European and native workings on three distinct lines of reef in the Konongo area and further north-east, situated in the western zone of schists close to the junction with the arenaceous beds. At the time of Teale's examination Lyndhurst Deep Level, Ltd., were sinking a shaft on the most easterly of the three reefs (Akyenase reef) on the portion of the Boabedroo concession now held by Konongo Gold Mines, Ltd.

Whitelaw did some field work in the area of the Bompata S.E. sheet, particularly to the east of the gold belt around Bompata, Juaso and Dampong, and although no report on this work by him is available, his field sheet proved very useful.

During short periods in 1934 and 1935, Junner made a rapid examination of the whole belt from Yapessa, south-east of Lake Bosumtwi, to Domiabra, and also examined the underground workings and prospecting operations.[2] In Geological Survey Memoir No. 4, "Gold in the Gold Coast," he gave a history and description of the mines and prospects.

A considerable amount of work has been done in recent years at Konongo mine by geologists working on behalf of the company. An excellent report (unpublished, 1938) by N. Yarkoff and J. L. Farrington, and also plans, sections, and rock collections made in 1940 by Dr. J. Chapman Brown have been made available to the writer, and microscopical examination by Dr. N. R. Junner of these specimens, and many of those in his own and the writer's collection, has been of very great assistance.

PHYSICAL FEATURES

The central and southern portions of the area, being well-watered, with numerous perennial streams, support a large native population, distributed in many large villages. Much of the original forest covering remains in the areas between the villages, and particularly on the hill ranges.

The geological structure of the area is reflected to a marked degree in the topographical features. The central and southern portions, with an altitude of 600-850 ft. above sea-level, are dominated to the south by the granite hill mass south-west of Juaso, which rises to over 1,900 ft. at its highest point; to the north by ranges of hills, carved out of Banket Series conglomerates, grits, quartzites and phyllites, with extensive intrusions of epidiorite on the flanks of pitching folds; and to the west and north-west by the broken hill range of the gold belt. This range increases in height north-eastwards, and from Attunsu onwards the Banket Series quartzites on its eastern flank form a parallel ridge. At Kwakawkaw the Upper Birrimian beds of the belt pitch beneath hard quartzites of the Banket Series, which from here northwards form a still higher range up to the Voltaian scarp. The eastern strip of Upper Birrimian beds, consisting mainly of highly weathered tuffs, makes no feature at all until it culminates in Brinsem hill east of Chichibiasi, which owes its existence to the resistance to weathering afforded by manganese concentration. West of the gold belt is a wide stretch of low ground, extending to the Anum river and beyond, occupied by Lower Birrimian phyllites and greywackes with granite intrusions, and drained by sluggish streams running westwards off the gold belt to the Anum.

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[1] *Ann. Rep. Geol. Surv. Gold Coast*, 1924-25, pp. 22-27.

[2] *Ibid.*, 1934, pp. 4-5.

West of the Brinsem-Mfraansa range of hills, and of a line running roughly down the centre of the granite mass in the south, the drainage is westwards to the Anum. All the other streams drain eastwards and southwards to the Pra. The larger streams, such as the Owire (Awere), Kume, the eastern Subin and the Onyimsu flow for long distances as strike streams in the cores of folds pitching to the north-east.

In the north, the Voltaian escarpment cuts sharply across the grain of the older rocks. To the north-west, around Wiawso, the escarpment overlooks ground of low relief occupied by Lower Birrimian rocks, and the precipitous sandstone cliffs, rising above well-wooded lower slopes, make a striking feature. In the north-east the escarpment faces equally high Tarkwaian hills; here the headwaters of many of the streams flowing southwards between the Tarkwaian hill ranges rise on top of the escarpment and plunge over waterfalls, sometimes as much as 100 ft. in height.

GENERAL GEOLOGY

Classification of Rocks

The geological formations may be classified as follows, from older to younger in ascending succession, except the intrusive rocks:

RECENT	Superficial Deposits . . .	Alluvium, soils, laterite; high-level sands, gravels and quartz rubble.
SILURIAN ?	Voltaian	Sandstones and grits with subsidiary conglomeratic beds and shales.

PRE-CAMBRIAN	Tarkwaian	Huni Sandstone.	Sandstone and quartzite.
		Banket Series .	Sandstone, quartzite, grits, breccias, conglomerates and phyllite.
		Kawere Group .	Conglomerate and quartzite.
	Birrimian	Upper Birrimian	Lavas, tuffs, greywacke, quartzite and phyllite; mainly altered to schists and hornfels.
		Lower Birrimian	Schists, greywacke and phyllite.
INTRUSIVE ROCKS			Epidiorite, amphibolite and dolerite sills and dykes (E). Granite (G.2). Granite, aplite, porphyry and felsite (G.1).

Geological Structure

The main structural features are brought out in the sections across the geological map. At the eastern end of the section on the line A-A′ the unsymmetrical open folds pitching to the north-east may be named the Bompata syncline, Adomfi anticline and Krofa syncline respectively from east to west. The Brinsem anticline, which succeeds the Krofa syncline, and along which the Upper Birrimian beds of Brinsem Hill pitch beneath Banket Series rocks, is isoclinal, and west of it is a succession of close isoclinal folds, all dips in the ground north of the gold belt being vertical.

In the south the resolution of pressures arising from post-Tarkwaian movements was conditioned by the presence of the Banso granite mass in the middle of the Tarkwaian basin, and Tarkwaian and Birrimian rocks are interfolded around its edge. On the western side the dips are all north-westerly at angles of 50°-80°, in conformity with those in the south-western part of the gold belt around Konongo mine. The Banket Series grits and quartzites in this area are highly sheared, and in places converted into quartz-sericite schists.

Around the northern edge of the granite the folding consists of two northerly-pitching anticlines and a syncline, complicated by subsidiary folds. The anticline to the east, which carries Upper Birrimian rocks northwards across the railway and road east of Juaso, is the southern extension of the Adomfi anticline; east of the granite the beds are again overfolded, with dips to the south-east, one of the synclines opening out northwards into the Bompata syncline.

The main system of joints in the area follows directions grouped about an E.-W. axis, with a subsidiary set running north and south. These are also the directions of the main faults in the mines, apart from strongly developed "graphitic" channels, which are probably strike-faults running nearly parallel to the strike of the country.

Description and Petrology

Birrimian System

Lower Birrimian.

The Lower Birrimian rocks, which are the oldest in the area, occupy the wide stretch of ground of low relief between the gold belt and the Anum river. They, and the granite masses intrusive into them, are very poorly exposed, but from the evidence afforded by the few exposures, from numerous pits sunk to determine the granite boundaries, and from the railway section in the south between Bomfa station and Odumasi, they consist mainly of phyllites, including black carbonaceous phyllites, with subsidiary greywackes and tuffaceous beds. Alternating bands of black phyllite and greywacke are fairly common. The granite bosses, which are offshoots of a large batholith to the west, are surrounded by aureoles of thermal metamorphism of varying but narrow width, in which the sedimentary rocks are converted to biotite—and quartz-biotite—schists. The rocks are everywhere steeply dipping, mainly to north-west, or vertical, and must be isoclinally folded, though this is difficult to prove. In the north the Voltaian boundary with these rocks ranges from some 750 ft. above sea-level to as high as 1,100 ft., affording evidence of considerable topographical relief in pre-Voltaian times.

Upper Birrimian.

These rocks occur in the gold belt, in which they form the country rocks of the gold-quartz veins, and in a parallel strip to the east, separated from the gold belt by Banket Series quartzites and phyllite. They also occur all round the granite mass south-west of Juaso, being found at varying distances up the hill slopes and sometimes forming buttressing hills. In the low ground surrounding the hill, they are intimately interfolded with Banket Series quartzite and grits.

The mode of occurrence of the Upper Birrimian in relation to the granite suggests that up to quite recent times, geologically speaking, it formed a protective covering to the granite. It is most unusual for granite to form marked positive topographical features in the Colony and Ashanti, yet as already stated this mass runs up to a height of over 1,900 ft. above sea-level, culminating in impressive tors which, owing to the thick forest growth, are only visible close at hand.

The Upper Birrimian sequence normally consists of lavas and pyroclastic rocks (" greenstones ") with hypabyssal igneous rocks, and subordinate phyllite, greywacke and schist. Persistent bands of manganiferous phyllite and gondite occur on practically a constant horizon in the formation in many parts of the Gold Coast, including the area under consideration. Some of the lavas, tuffs, and interbedded sediments were permeated by siliceous hydrothermal solutions, possibly derived from the same source as the lavas, soon after deposition, forming hornstones (grey to black fine-grained granular aggregates of quartz) and epidosites (similar aggregates of epidote and quartz).[1] These hornstones should not be confused with the hornfelses in the mines, which are different in origin and nature.

In the gold belt and the parallel strip to the east lavas seem to be subsidiary to tuffs, phyllites, greywackes and hornstones. A manganiferous horizon in the Upper Birrimian persists right through the gold belt and is particularly well-developed on and near the railway at Odumasi, and to a less extent at Brinsem hill in the eastern strip. These two occurrences were investigated by Teale in 1924, but found to be too low grade to be of economic importance, though a large quantity of this low grade ore exists at Odumasi.[2]

In the vicinity of the auriferous channels the Upper Birrimian rocks consist of hornfels (usually biotitic and garnetiferous), biotite-schists, chlorite- and calc-chlorite schists and carbonaceous phyllites, impregnated near the gold-quartz veins by sulphides such as arsenopyrite, pyrite, pyrrhotite and occasional chalcopyrite. The hornfels in the hanging wall of the Akyenase reef carries scattered rounded pebbles of quartz up to an inch or so in diameter.

In the neighbourhood of the Juaso granite the rocks were metamorphosed and later subjected to intense pressures in post-Tarkwaian times. A very dark green, fine-grained actinolite-schist, with veins and nests of quartz and epidote, is the commonest type, with subsidiary quartz-biotite-schists and lustrous sericite-schists, these last often being severely crumpled.

Tarkwaian System

Kawere Group.

The characteristic Kawere conglomerate, consisting chiefly of squeezed pebbles of Upper Birrimian volcanics, without quartz, in a spotted siliceous matrix, sometimes accompanied by a little spotted Kawere quartzite, was noted in three localities, viz.: (1) in a short and narrow strip in an isoclinal fold near the farmstead of Owirija, west of the Konongo-Agogo motor-road north-east of Domiabra; (2) in a small outcrop lying between Upper Birrimian actinolite-schists and Banket Series beds, on one limb of a synclinal fold crossing the Debia Su, south of Juaso railway station; (3) near Asuboa, a village to the north-east of Dampong. The last-mentioned occurrence is of interest because of the discovery of diamonds in 1939 by the natives of Asuboa in the Abodiasi and Aduhima streams near that village. These streams rise on the boundary between Upper Birrimian and Tarkwaian rocks on the south-eastern flank of the Bompata syncline. After investigation of the occurrence, which is incidentally not of economic importance, the writer concluded that the proximate source of the diamonds was the basal bed of the Tarkwaian, which is here typical Kawere conglomerate, thus bringing it into line with the occurrence in the Bonsa diamond-field, south of Tarkwa. This basal Tarkwaian varies in character along its strike in this neighbourhood. At Dampong it is represented by a remarkable sheared breccia, consisting of large flat fragments of lustrous sericite-schist in a gritty quartzose matrix. Where the boundary crosses the railway 2 miles east of Asankare (Bompata) station, there occurs a thick bed of breccia conglomerate, composed of angular fragments of Birrimian tuffs, with squeezed and dimpled pebbles of quartz and some of pink porphyry, up to 5 in. or so in diameter, in a gritty quartzose matrix. These last-mentioned occurrences resemble Banket Series breccia and breccia-conglomerate more than the Kawere, but are not typical of either.

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[1] Geology of the Gold Coast and Western Togoland, by N. R. Junner; *Bull. No.* 11, *Geol. Surv. Gold Coast,* 1940, pp. 6 and 9.

[2] *Ann. Rep. Geol. Surv. Gold Coast,* 1924-25, pp. 26-27.

Greenish- to buff-weathering fine-grained quartzites of the Kawere group occur, poorly exposed, over fairly wide areas in synclines south and south-west of Dampong. No conglomerate was noted in these areas, but it occurs along the strike of these beds south of the area mapped.

Banket Series.

A glance at the geological map will show that by far the greater part of the extensive Tarkwaian outcrop in the area consists of Banket Series rocks. These are divisible roughly into three groups. In the lowest group are grits, quartzites, and sandstones with sporadic developments of fine to coarse breccia, and bands of conglomerate which are thin and impersistent except near Bompata, where they are very well-developed with accompanying grits and quartzites and intruded by sills of epidiorite and amphibolite. Some beds of fairly well-packed conglomerate with pebbles up to 1 in. diameter occur in this neighbourhood, but a commoner conglomerate type consists of bands of pea-size pebbles in grit or quartzite. These conglomerates, and also occurrences of Banket Series breccia conglomerate such as those between Domiabra and Oponasi, Domiabra and Juansa, at the bridge over the Owire on the Juansa-Fwidiem road, and also on the railway two miles or so west of Juaso, were tested for gold with poor results, although gold does occur in them.[1]

The middle division of the Banket Series consists of phyllite with impure felspathic quartzite and sandstones. A well-developed and persistent phyllite horizon runs from the neighbourhood of Patriensa, east of the gold belt, northwards through Juansa. Thence it is traceable round the folds in the north of the area as far as the Bompata syncline on the east, where it succeeds the conglomeratic beds, and like them is heavily intruded by epidiorites and amphibolites. In the closely-folded area of the neighbourhood of the gold belt, where pressures were much more intense than further east, the phyllite sometimes resembles a Birrimian rather than a Tarkwaian phyllite, but tracing it on the same horizon around the flanks of the folds to the east clearly proved its Tarkwaian age.

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[1] *Ann. Rep. Geol. Surv. Gold Coast*, 1934-35, p. 4.

The phyllite zone is succeeded by ordinary Banket Series grits and quartzites, which are best seen in the valley of the Onyimsu in the north-east, where, owing to the north-easterly pitch of the Bompata syncline, they give place to Huni Sandstone beds in the centre of the fold.

Huni Sandstone.

Fine-grained felspathic quartzites of this group occur, very poorly exposed, in the Bompata syncline, as above mentioned, and in a subsidiary syncline west of Asuboa.

Voltaian System

The boundary of the Voltaian with the older rocks takes a wavy, but in general westerly course from the south-east corner of the sheet Bompata N.E. to the Konongo-Agogo motor-road 1½ miles south of Fwidiem, and thence to the neighbourhood of Yenamponasi. From here it swings north-westerly past, and slightly to the north of Wiawso. As far as Yenamponasi, the escarpment is confronted by high Tarkwaian hills, but west of that village it appears as impressive vertical cliffs overlooking low-lying ground.

The Voltaian sediments have a maximum thickness of about 1,000 ft. in this area. They were deposited on an uneven surface, and the height of the contact varies from as little as 750 ft. to as much as 1,700 ft. above sea-level. The Birrimian phyllites and greywackes, and associated granite intrusions, which form scarcely any positive features at all to the south, run up into the escarpment to as much as 1,100 ft. in places, though as might be expected, the highest hills in the old terrain were formed by the Tarkwaian (Banket Series), and the boundary is at a generally higher level on these rocks. No evidence of large-scale faulting was found, and the Voltaian beds are mainly undisturbed and either horizontal or near-horizontal, whatever the height of the boundary.

The rocks are almost entirely arenaceous and belong to the Upper Sandstone division of the System. Shale bands occur in the sandstones high up in the sequence, for instance, near Agogo Rest House, and were noted at the base in two localities only, viz., in the Owire (Awere) stream south-east of Fwidiem, and in the Sambong stream near Acheriso, north-west of Wiawso. These occurrences of basal shale, though widely separated, are very similar, consisting of dark blue-grey micaceous shale with thin, lighter coloured, more sandy bands. In the Owere the shale lies horizontally on vertical Banket Series grits and quartzite; it is about 10 ft. thick, and is immediately overlain by 20-30 ft. of slabby fine-grained sandstone with clay galls and thin shaly bands, which is in turn followed by more massive ferruginous sandstones.

Along the Konongo-Agogo motor-road near Fwidiem, and to the east and west of it, the sandstones may be divided into three groups. In the lowest, ferruginous sandstones and grits predominate, though white or buff-coloured rocks occur. The ferruginous beds are either a deep uniform red or purplish-red, or may be irregularly banded or stained with pink or purplish iron oxide. Small white spots of kaolin after felspar are fairly characteristic. Some of the grits consist of highly rounded, closely-packed quartz grains, usually, but not always, cemented with iron oxide.

The middle group in this eastern section is made up of sandstones characterised by irregular seams, flakes, pellets and galls of clay. When reasonably fresh, they are hard, fine-grained and of a greenish colour, with the clay seams and flakes of deeper, olive- or bluish-green. When weathered, they are buff-coloured, brown-spotted rocks. This group generally forms the vertical cliffs and waterfalls of the neighbourhood.

The topmost sandstones range from a height of some 1,400 ft. to the tops of the hills, the highest of which are 1,800 to 1,850 ft. above sea-level. A brown and white mottled sandstone is the commonest type, but grits and occasional shale bands occur. Some of the sandstones and grits are ferruginous, but these are not nearly so prominent as in the lowest group.

The middle or clay gall group has a thickness in this neighbourhood of some 200 ft., while the ferruginous group varies from a few feet in thickness to a maximum (around Fwidiem) of some 250 ft., being thickest where the contact is lowest. The whole sequence, as stated above, belongs to the Upper Sandstone division of the Voltaian, and reaches here a maximum thickness of about 1,000 ft.

From Yenamponasi westwards the clay galls and seams are found from top to bottom of the sandstone, although here again the lower beds are generally ferruginous. Cross-bedding, which is a characteristic feature of the sandstone here, is beautifully shown in the cliffs, and indicates that the main source of the currents was to the south-south-east, as also do ripple markings where noted. The foresets of the cross-bedding are usually short, and dip at angles up to 30°. The regional dip in this area is gentle, about 5° to the north-east, whereas around Fwidiem and east of it the beds are horizontal, except where locally disturbed. Conglomeratic beds are rare on this southern scarp section, though they are common north of Agogo.

The Voltaian beds of the Gold Coast are identical in appearance with the *Grès siliceux horizontaux* of Bobo Dioulasso, Ivory Coast, which are regarded by some geologists, on the evidence of the graptolites in similar beds in French Guinea, as being of Gothlandian (Silurian) age.[1]

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[1] *Bull. No.* 11, *Geol. Surv Gold Coast*, 1940, p. 24.

Intrusive Igneous Rocks

Pre-Tarkwaian Intrusions.

Cape Coast Type Granite.—An offshoot from the eastern boundary of the great batholith of Cape Coast type granite, which occurs to the north, north-east and east of Kumasi, crosses the north-west corner of the area mapped, and to the south-east of this boundary a completely detached offshoot outcrops near Petrechi. For about 5 miles south-west of Petrechi, the eastern boundary of this detached boss is only about 3 miles from the main gold channel, but its westerly trend subsequently carries it to a distance of about 6 miles from Konongo mine.

The granite is here a black and white, medium to coarse-grained, biotite-rich rock, but two-mica types occur further west, and also in the Petrechi mass.

According to Junner[1] the Cape Coast type of granite normally contains approximately 20-25 per cent. quartz, 30 per cent. orthoclase and microcline, 20-30 per cent. plagioclase (albite to andesine) and about 20 per cent. biotite, muscovite and chlorite. An analysis of a two-mica type of Cape Coast granite from the Kumasi batholith is given in Table I.

Winneba-Wa Type Granite.—The Banso granite, of which the northern part forms Juaso hill, is mainly a porphyritic biotite-granite with prominent pink, reddish, or grey phenocrysts of felspar (microcline) up to an inch or more in length. It has all the characteristics of the Winneba or Wa type, which is generally regarded as being younger than the Cape Coast and older than the Dixcove granite. In this area it is intrusive into the Upper Birrimian and is certainly older than the Tarkwaian. The Tarkwaian rocks interfolded with the thermally metamorphosed Upper Birrimians around the edge of the granite show no signs of alteration except shearing due to pressure, and none of its offshoots are found to cut the Tarkwaians. According to Junner, the normal Winneba-Wa granite contains 20-40 per cent. quartz, 15-30 per cent. orthoclase, 0-25 per cent. microcline and microcline-perthite, 15-30 per cent. plagioclase, 5-15 per cent. biotite and hornblende. The granite and Upper Birrimian are cut by veins and dykes of aplite, pink and dark grey fine-grained quartz-porphyries and a rock consisting of drawn-out streaks and blebs of pink felsite in a horny quartz matrix.

An analysis of a porphyritic granite from near the triangulation pillar at the highest point of Juaso hill is given in Table I. This is more sodic than the average Winneba granite, and is very similar to some analyses of Dixcove granite.

Dixcove Type Granite.—On the eastern boundary of the area typical hornblende-granite or granodiorite of the Dixcove type occurs athwart the new motor-road and the railway. This is a

[1] *Bull. No.* 11, *Geol. Surv. Gold Coast*, 1940, p. 37.

portion of a large mass which occurs to the east of the area mapped. It is in contact with Upper Birrimian sericite-schists and tuffs, and a massive, highly pyritic, quartz-tourmaline vein marks this contact where it crosses the new motor-road near Adansi.

Analyses, one of which is given in Table I, show that the Dixcove granite suite is relatively rich in soda and poor in potash, and although neither this type of granite nor the characteristic bipyramidal quartz-porphyry which is usually associated with it have been noted on the surface in the immediate vicinity of the gold belt, there is an acidic intrusion near the Awere reef on No. 9 level at Konongo mine which is, according to Junner, a sodic porphyry. Other small acidic intrusions in the mine, for example, in the No. 4 level cross-cut from the Akyanase to the Odumase reef in the South-west Section are, as noted by Yarkoff (unpublished report, 1938), accompanied by an impregnation of the wall rocks with sulphides similar to that in the neighbourhood of the gold-quartz veins. Many auriferous quartz reefs in the Gold Coast are associated with the Dixcove granite or its offshoots. The geographical association of the granite with Upper Birrimian rocks is most marked,

TABLE I.—ANALYSES OF GRANITES

Sample No.	15500 %	H.3608 %	1468 %
SiO_2	72·59	68·57	64·44
Al_2O_3	15·18	16·01	17·82
Fe_2O_3	0·13	0·06	1·94
FeO	1·01	1·48	1·33
MgO	0·45	0·77	1·14
CaO	1·17	2·47	5·12
Na_2O	3·86	5·14	5·06
K_2O	4·52	2·96	1·29
H_2O+	0·17	0·68	1·70
H_2O-	0·14	0·12	0·08
CO_2	none	not detected	none
TiO_2	0·12	0·34	0·32
ZrO_2	—	not detected	trace
P_2O_5	0·27	0·12	0·16
Cl	trace	—	0·01
S	0·05	0·03	0·02
MnO	0·02	0·03	0·07
SrO	none	—	0·01
BaO	none	0·16	0·08
Li_2O	—	—	trace
Cr_2O_3	—	not detected	—
V_2O_5	—	faint trace	—
	100·20	99·94	100·59
Less O for S	0·02	0·01	0·01
	100·18	99·93	100·58

15500	Biotite-muscovite-granite, Insuintem-Asamankuma, Kumasi district. Analyst, H. L. Riley.
H.3608	Porphyritic biotite-granite, Triangulation pillar, top of Juaso Hill. Analyst, Miss R. C. Groves.
1468	Saussuritised soda-rich granite, Dixcove, Axim district. Analyst, H. F. Harwood.

and it is certain that its composition has been modified by some assimilation of the surrounding rocks. It occurs in smaller masses than the Cape Coast or Winneba types, and the possibility of its being a modification of one of these granites cannot be overlooked; in this connection the Winneba granite is more sodic in composition than the Cape Coast.

As stated above the Tarkwaian rocks of the area show no signs whatsoever of thermal metamorphism though they have been highly sheared, especially in the south and west, by the intense pressures which caused their interfolding with the Birrimians. No veins of porphyry or any other kind of granitic offshoot have been seen in them, and the evidence points to the pre-Tarkwaian age of all three types of granite.

Post-Tarkwaian Intrusions.

Sills of amphibolite and epidiorite of post-Tarkwaian age, and resembling those in the Obuasi and Tarkwa goldfield, are almost as abundant in this area as in the Tarkwa goldfield. The intrusions are practically always concordant, emplaced along the bedding planes of the Tarkwaians, especially the conglomeratic and phyllitic divisions, or at the junction of Tarkwaian and Birrimian rocks. Few, if any, cross-cutting dykes occur. The similarity of the intrusions, both in petrographic character and general mode of emplacement, to the basic intrusions of the Tarkwa goldfield, the Obuasi district and elsewhere is apparent in the field and confirmed by microscopic examination: increasing knowledge of the main Tarkwaian geosynclinal basin gained in the last few years has shown that this post-Tarkwaian igneous activity was more extensive than was formerly supposed, and it forms an important phase in the igneous cycle of the Gold Coast.

The acidic intrusions, mainly quartz- and albite-porphyries, which are so closely associated with some of the basic dykes and sills in the Tarkwa goldfield, have not been noted in this area, and the finer-grained dolerite and quartz-dolerite (" green dyke ") types of that field are uncommon here. The commonest types are medium to coarse-grained gabbros and olivine-gabbros, with a little norite, mainly converted to epidiorite by the saussuritisation of the felspars, alteration of the pyroxene to uralitic hornblende, and development of carbonate, chlorite, sericite and epidote.

There is considerable variation in the appearance of the rock in the hand specimen, due to differences in the relative amounts of felspar and hornblende, from almost black amphibolites, through typical epidiorites in which the minerals are in roughly equal proportions, to paler types in which cloudy felspar is greatly in excess.

As will be seen from the map, the intrusions are concentrated in the eastern half of the area, the western half, including the gold belt, being singularly free from any but occasional small outcrops.

The sills are thickest and most numerous in the neighbourhood of Bompata, where they form the commonest rock type. Two of these sills persist to the westward and outcrop along the flanks of the Adomfi anticline and the Krofa syncline, becoming progressively thinner and ultimately dying out. The mode of occurrence of the sills indicates that they were folded with the rocks into which they were intruded and were thus emplaced before the post-Tarkwaian folding movements.

In the south-east of the area especially, schorl-quartz veins, often pyritic, commonly occur in and near the basic sills; such veins are also common, associated with the similar intrusions in the Tarkwa goldfield, and seem to be a characteristic feature of this igneous activity. It seems probable that the last phase is represented by the myriads of barren white quartz veins which cut both Birrimian and Tarkwaian rocks, and which cut across the auriferous quartz veins of the gold belt. The denudation of these has given rise to widespread deposits of angular to sub-angular quartz rubble, which are sometimes lateritised, as for example along the railway east and west of Konongo station.

DESCRIPTIONS OF MINES AND PROSPECTS

Konongo Gold Mines, Ltd.

This company was formed in 1933 by purchase of the southern half of the Boabedroo concession from Lyndhurst Deep Level, Ltd. (see Fig. 1). The mine is a mile from Konongo station, which is 153 miles by rail from Accra and 208 miles from Takoradi. By road it is some 34 miles from Kumasi. The Lyndhurst company had developed the Akyenase reef to No. 3 level, 350 ft. from surface, and sunk a main incline shaft to No. 4 level. Owing to the unsuitability of the inclined shaft, a vertical shaft was sunk 750 ft. to the north-east, to cut the Akyenase reef at 700 ft. This was completed down to a depth of 155 ft.[1] The Konongo company have extended this shaft, the Akyenase Central Shaft, to No. 1 level, and sunk another vertical shaft (South Shaft) at a point 2,500 ft. south-west of the above, to develop the south-western ore shoot in the Akyenase channel. This shaft is down to No. 6 level. The Awere and Odumase[2] reefs, 450 ft. and 1,300 ft. respectively west of the Akyenase, have been developed from small vertifical shafts and from internal shafts and winzes. Development is down to No. 11 level in the Akyenase Central Section, to No. 6 level in the South-West Section,[3] and No. 9 level on the Awere and Odumase reefs. There are cross-cuts between the Awere and Akyenase reefs on Nos. 3, 4 and 9 levels, Central Section, and between the Odumase and Akyenase reefs on Nos. 4 and 9 levels, South-West Section.

[1] Gold in the Gold Coast, by N. R. Junner; *Mem. Geol. Surv. Gold Coast, No.* 4, 1935, p. 35.

[2] The reef is the Odumase reef but the name of the town is Odumasi.

[3] The Akyenase reef in the South-West Section has recently been intersected in a cross-cut from the Odumase reef on No. 9 level.

In 1938 the management decided on the sinking of a main vertical circular shaft, not far from the site of the Odumase shaft. This is now (September 1941) down to a depth of 1,107 ft., at which point sinking was suspended pending the installation of a new electric hoist.

Production.—From the commencement of production in June 1936 to September 30, 1940, the mine treated 428,995 tons for a yield of 180,229 oz. of fine gold. During the year ended September 30, 1940, 138,087 tons of ore were treated, leaving an ore reserve of 452,054 tons averaging 9·48 dwt. per ton.

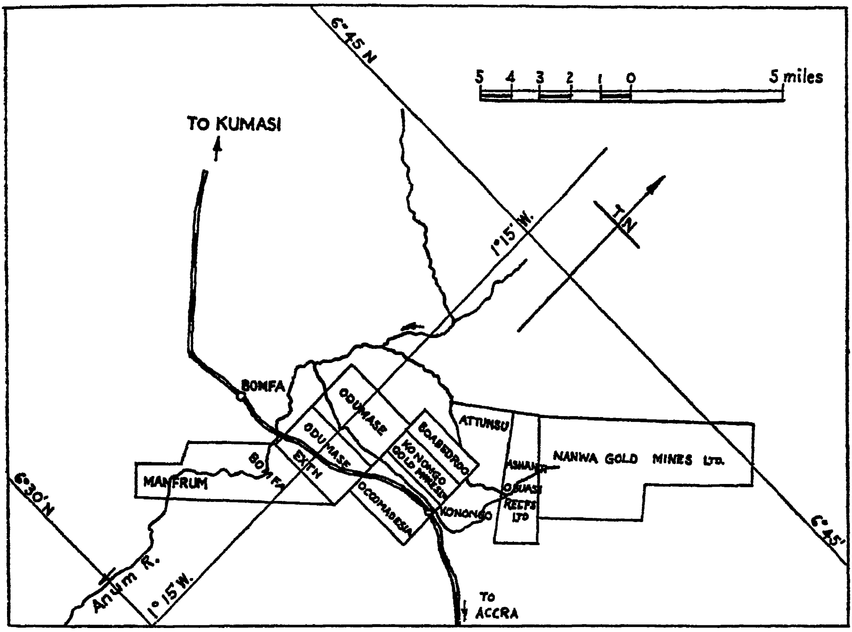

FIG. 1—CONCESSION PLAN.

Geology.—The zone of mineralisation at Konongo consists of three main reefs—Odumase, Akyenase and Awere—with subsidiary mineralised zones, occurring in a width of about 1,300 ft. in Upper Birrimian rocks. The outcrops of all three main reefs are marked by native workings, consisting chiefly of open cuts. These are most prominent on the Akyenase, but native workings on the Odumase strike were severely restricted by the fact that north of the present shaft the reef line coincides with a swamp almost all the way to the Boabedroo workings, while south of the shaft the Awere river (in this area flowing across the strike from the east) turns sharply to south-west when it reaches the Odumase reef line.

Of the subsidiary mineralised zones there are, from east to west, (1) a narrow but persistent quartz vein in the hanging-wall of the Akyenase fissure zone; (2) the David reef, which is exposed in the hanging-wall cross-cuts in the Akyenase Central Section, lying on the foot-wall side of the Zongo channel; (3) the Zongo channel, some 230 ft. from the Akyenase; (4) a reef to the south-west of the Awere, first intersected on No. 9 level.

The Akyenase reef is close to the boundary with the Tarkwaian rocks, but not so close as had previously been thought (*see* Section). It nowhere passes into the Tarkwaian, as some observers have maintained, and the mine conforms with all the other gold-quartz mines of the Gold Coast, in that the reefs lie entirely in Birrimian rocks. Detailed surface mapping has demonstrated the true relations. An infolded tongue of Banket Series grits and quartzites, bounded by Birrimian rocks, is well exposed in a cutting east of milestone 31 on the Kumasi-Konongo motor-road. The tongue decreases in width north-eastwards and is very narrow in Odumasi village, where Banket Series quartzite occurs immediately to the east of the Zongo Shaft of Lyndhurst Deep Level, Ltd. This shaft is on the Zongo channel, which is mentioned above as occurring some 230 ft. west of the Akyenase reef in Konongo mine. From this point north-eastwards the outcrop continues to narrow rapidly, and it fades out on the north bank of the Awere river, just west of the Akyenase reef line. Another small infolded patch of Tarkwaian, not connected to the main Tarkwaian outcrop, occurs to the north-east of the South Shaft, near to and north-east of the point where the road to this shaft branches off from the road from Konongo to the General Office.

The Awere affords a very good section where it flows across the strike just south of the South Shaft. East of the point where the line of the Akyenase outcrop reaches the river, there is an almost continuous outcrop, mainly of biotite-hornfels, similar to that enclosing the Akyenase reef at depth, extending for over 400 ft. on the foot-wall side of the reef line. A little further on, across the river where it bends to the east-north-east, Banket Series quartzite occurs. This is the true boundary between the Upper Birrimian and Tarkwaian and thus the Akyenase reef lies between 400 and 500 ft. from the Tarkwaian boundary, and not immediately at the boundary.

Underground in the mine excellent sections across the whole reef zone are afforded by the long crosscuts from the Akyenase to the Odumase reef on Nos. 4 and 9 levels, South-West Section, and from the Akyenase to the Awere horizon on Nos. 3, 4 and 9 levels, Central Section. All show the same succession, consisting (from east to west) of hard, massive, garnetiferous biotite-hornfels, dark carbonaceous phyllite, calc-chlorite-schist, and thence alternating biotite-hornfels, biotite-schist and carbonaceous phyllite. The hornfels in the immediate hanging-wall of the Akyenase reef contains scattered, rounded pebbles of quartz up to an inch or so in diameter. The Akyenase lies in the first belt of biotite-hornfels, and the Zongo channel, consisting of a zone up to 50 ft. in width of

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" graphitic " gouge with some quartz and crushed country rock, in which occurs a bed of gondite (manganese-garnet, rhodochrosite and quartz rock), is in the immediate foot-wall of the calc-chlorite-schist. The Awere and Odumase reefs lie in the western zone of biotite-hornfels, schist and phyllite, beyond the calc-chlorite schist, and in this zone some small acidic dykes occur in the South-West Section, between 430 and 500 ft. from the Akyenase drive. This is about the horizon of the Awere fissure, but the fissure does not extend so far south. Several zones of " graphitic " gouge of varying width, and marking the position of strike-faults, occur between the Awere and Odumase horizons.

The general strike is N.37° E., and the dip, though mainly about 70°-75°, varies from 60°-80° to north-west.

Geological Structure.—Although the mine lies in an area of isoclinal folding, there does not seem to be any repetition within the width of beds exposed, as the only markers—the pebbly hornfels in the hanging-wall of the Akyenase, and the gondite in the Zongo channel—do not recur across the strike. The quartz veins with the exception of the south-west end of the Awere reef, are almost parallel in strike and dip with the country rocks. They dip a little less steeply, and the quartz lenses are best developed and show the best values where they cut slightly across the strike.

There are three main groups of faults. The most numerous strike E. to W. and E.S.E. to W.N.W. and dip either steeply north or steeply south. Striations on the fault planes dip 45° to the east, showing the obliquity of the movements. Displacements are usually small and never amount to more than a few feet, usually less. A subsidiary system has a N.-S. strike and low dips to the east. The dip being against the dip of the reef, they act as small thrust faults.

The zones of " graphitic " gouge occurring at intervals across the strike, of which the Zongo is the widest and strongest, are possibly post-mineralisation strike-faults. The Zongo fault must have been originally a locus of quartz mineralisation. There is not much quartz in it at Konongo mine, but in the Zongo workings at Odumasi it contains a strong body of quartz which, by subsequent movement along the channel, has been broken up into crushed lenses, as pointed out by Yarkoff (*op. cit.*) The " graphitic " zones are located, as might be expected, in the more fissile and least competent beds, the carbonaceous phyllites and schists, which in and near the fault planes have been mashed and worked up into a " graphitic " gouge or pug, shiny-black in appearance and smooth to the feel. The term " graphitic " is a misnomer as the mineral graphite is not present and indeed the percentage of carbon is low. A similar gouge occurs in and on the walls of the Odumase channel, and to a less extent in the Awere but is not found in the Akyenase.

The rocks are strongly jointed in directions grouped about

E.-W. and N.-S. axes, that is, parallel to the strike of the main faults, and some of the joints are filled with barren white quartz.

Igneous Intrusions.—In view of the existence at no great distance both to the west and south-east of large masses of granite it is surprising that the intrusions in the mine are so small. They consist only of the series of small acidic dykes occurring between the Awere and Odumase horizons in the South-West Section, and a porphyry in the foot-wall of a fault which possibly cuts out part of the Awere reef on No. 9 level. (See Fig. 2.)

The dykes in the South-West Section, examined microscopically by Junner, consist of an intergrowth of quartz and felspar (mainly albite) with a variable amount of porphyroblastic biotite (partly chloritised), some carbonate in blebs and veins, and black iron ores. The dykes are traversed by quartz and quartz-tourmaline stringers, and veinlets of carbonate, and the biotite-schist enclosing one of the dykes is impregnated with sulphides similar to those in the reefs and wall-rocks.

In the hand-specimen the porphyry on No. 9 level is a pinkish fine-grained rock with pale greenish veins and patches. In thin section it shows an intergrowth of quartz and albite, with abundant sericite, granular carbonate and some leucoxene.

Quartz-tourmaline (schorl) veinlets and stringers are common in the mine. Their origin is uncertain, as similar but larger veins are associated with the post-Tarkwaian basic intrusions, and it is possible that these, and also the veins of barren white quartz which cut the auriferous quartz, are of post-Tarkwaian age.

The Akyenase Reef.—The reef consists of two lenses of quartz corresponding with the ore-shoots, separated by a long stretch in which the fissure contains little or no auriferous quartz. The lenses are from 1 to 3 ft. in thickness, occasionally bulging out to greater widths or pinching to little more than a stringer. The values are best where the quartz is well developed. Outside the lenses the fissure is thin and difficult to follow and there is little wall-rock mineralisation. This mineralisation is intense in the ore-shoots, and consists of arsenopyrite, pyrite, pyrrhotite and a little chalcopyrite disseminated through the reef and to a much greater extent in the wall-rocks, which carry values in the immediate vicinity of the reefs, in some places higher than those in the reef. Farrington (unpublished report, 1938) noted a small quantity of sphalerite in one of the polished specimens of Akyenase ore examined by him, and states that a trace of zinc was found in analyses of Akyenase quartz. Lead was not found in any of the reefs. Mill concentrates examined by the Imperial Institute contained traces of bismuth and copper but no tellurium or antimony. In addition to the sulphides, carbonate, tourmaline and some biotite and sericite occur. The quartz in the south-west lens is whiter in colour and less sulphidic than that in the Central or north-east lens. The latter shows a tendency to darken in depth and in places in the lower levels is almost black, similar to the black Zongo quartz (*vide infra*). Both lenses show a tendency to split and throw off branch veins at their extremities. This occurs in the upper levels at both ends of the south-west lens, but so far only in the lower level at the north-east end of the north-east lens. One vein in the hanging wall of the zone of fissuring is very persistent, especially in the South-West Section, although seldom more than a foot or so in width.

There is only a little evidence of post-mineralisation movement and no development of " graphitic " slips and gouge such as occurs in the Odumase channel, but the quartz shows considerable strain-polarisation effects and partial recrystallisation.

The south-west limit of the north-eastern ore-shoot is well defined and has a steady pitch of 30° to the north-east in the vertical section. The north-east limits are less regular, but the general effect is a pitch to the north-east at a steeper angle than at the south-west extremity, so as to give a steady shortening of the shoot in depth.

The pitch of the south-west lens is less easily determined, owing to the more patchy occurrence of the values. Yarkoff (*op. cit.*) pointed out that the lens really consists of two portions, a main and a south lens separated by a short gap, the values in the main lens being lower and more erratic than in the south lens. The gap between the two lenses pitches north-east, and the same seems to be true of the splits in the reef where spurs are thrown off.

The Odumase Reef.—The channel in which this lens occurs is much stronger than the Akyenase and Awere fissures, and it seems clear that it is the main channel of the gold belt. It forms a pronounced line of weakness at the surface and is persistent along the strike, as the Boabedroo lens, 4,500 ft. to the north-east, appears to be in the same channel. Post-mineralisation movement along it is shown by development of " graphitic " gouge on the walls and in the channel itself, the latter arising from the shearing of lenses of carbonaceous country rock. The reef consists of a main lens coinciding with an ore-shoot pitching steeply south-west, with subsidiary lenses to the south-west and one to the north-east. The quartz in the lenses is strongly laminated with bands and streaks of carbonaceous matter, and contains inclusions of country rock which are impregnated with sulphides, mainly acicular arsenopyrite. Sulphides are not common in the quartz, which carries carbonate and some biotite and sericite. In the upper levels at the south-west end the reef is divided by a parting into foot-wall and hanging-wall sections and there is also a split in the channel at the north-east end.

The Awere Reef.—This reef consists of a short but rich lens of quartz in the Central Section of the mine. It is not comparable with the Akyenase and Odumase reefs, as outside the limits of the quartz there is no fissure which can be followed along the strike.

The reef includes a main ore-shoot pitching steeply south-west between Nos. 2 and 6 levels, and flattening somewhat below this, with narrow subsidiary shoots south-west of it, also pitching in the same direction (Yarkoff, *op. cit.*).

In the upper levels at its south-west end the reef makes several sharp turns at right-angles before returning to the normal strike, giving the appearance of folding. The turns in the reef pitch to south-west parallel to the ore shoots. On No. 6 level the south-west end of the reef turns at right-angles in the same way, and the structure as a whole on this level resembles a sharp anticline with one long limb. On No. 9, the lowest level in this section of the mine, the reef in plan is as shown in Fig. 2. Here the anticlinal appearance is even more pronounced, the longer limb being much shorter than on No. 6 level, and ending against a strong fault at the contact of the sheared carbonaceous schist, in which the reef lies, and a body of porphyry in the foot-wall. The strike of the country does not appear to turn with the turn or turns in the strike of the reef on any of the levels, and it would appear that the latter is deflected into a zone of cross-fracturing and is not folded.

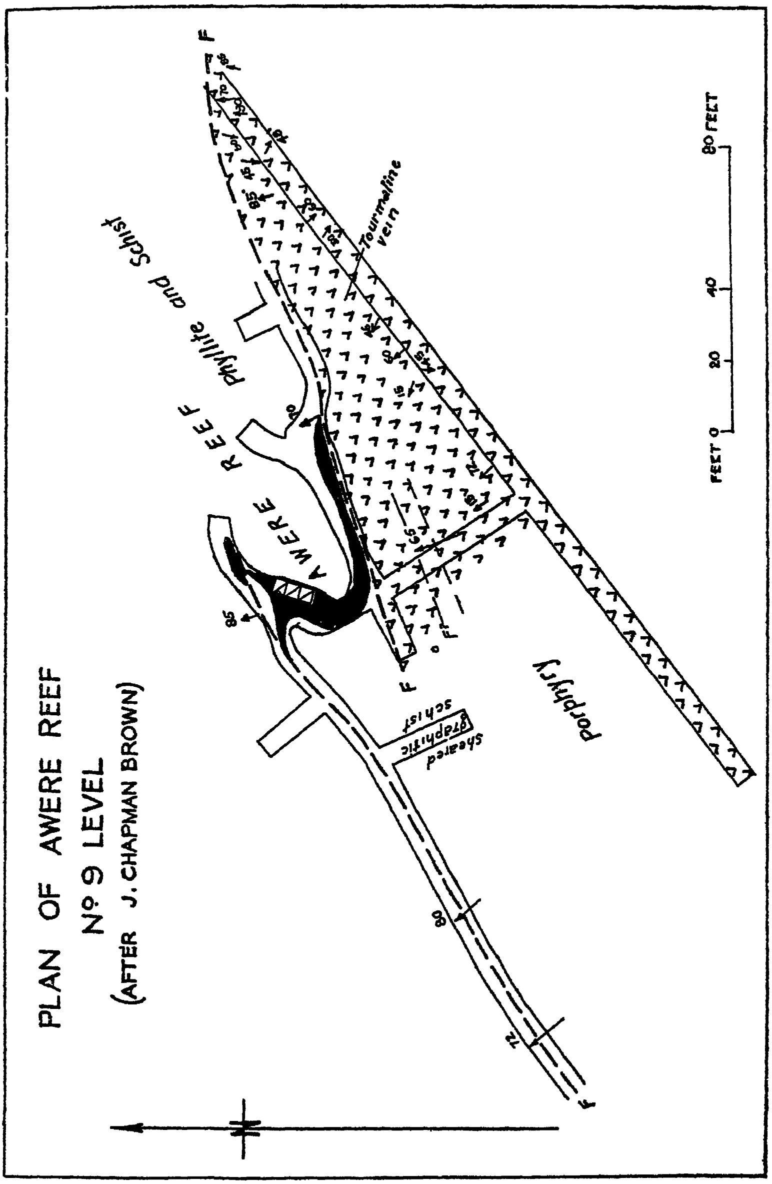
Subsidiary Reefs.—The *David Reef* is exposed in the hanging-wall cross-cuts from the Akyenase to the Awere reef in the Central Section. It is essentially a zone heavily impregnated with sulphides, especially needles of arsenopyrite, with irregular veins and stringers of quartz. Some driving has been done on one of these veins, 170 ft. from the Akyenase drive, on Nos. 4 and 5 levels, Central Section, and short lengths of payable ore exposed.

The *Zongo channel* which, as previously stated, is a wide zone of graphitic gouge and crushed country rock, is not important in Konongo mine, as it contains very little quartz. A little driving was done on a vein of quartz in the channel in the South-West Section, with poor results. The channel, both here and at the Zongo workings in Odumasi village, is characterised by very dark, almost black quartz.

Recently, on No. 9 level, a cross-cut towards the Odumase from the Awere horizon intersected a vein of quartz situated not far from the Awere line but some 500 ft. south-west of the Awere lens. This was driven on to the north-east and south-west, and shown to have a length of 670 ft. and an average width of 21 in. and to carry moderate values. The ground in which this reef lies has never been exposed by any workings above No. 9 level.

Origin of the Reefs and Summary of Reef Characteristics.

The reefs lie entirely in Upper Birrimian rocks, in a zone of mineralisation some 1,300 ft. in width. The most easterly reef, the Akyenase, lies 400-500 ft. from the main Birrimian-Tarkwaian boundary. The succession consists of hornfels, schists and phyllites, which before alteration were felspathic quartzites, greywackes, tuffs and phyllites, and lavas. The main reefs lie in the massive hornfelses and had their origin in the uprising of high-temperature hydrothermal solutions into zones of fracture parallel to each other



PLAN OF AWERE REEF
No. 9 LEVEL
(AFTER J. CHAPMAN BROWN)

FIG 2

and nearly parallel in strike and dip with the country rocks. The wall rocks were silicified, with development of biotite and carbonate, and impregnated with arsenopyrite, pyrite, subsidiary pyrrhotite and a little chalcopyrite. Sulphides were also deposited to a less extent in the fissures along with quartz and most of the gold, though gold also occurs in the wall-rocks near the reefs. The quartz in the reefs is laminated, due to inclusions of country rock or elongated streaks of carbonaceous matter, and tends to darken in colour in the lower levels. It shows the effects of shearing after deposition. The original, coarsely-crystallised quartz is wholly or partially recrystallised into a fine-grained mosaic, with minute cracks and partings. In thin sections of specimens showing visible gold, the latter can be seen filling minute cracks or cavities alone or in mechanical association with sulphides, especially arsenopyrite. The auriferous quartz is intruded by veins of barren white quartz. The Akyenase fissure is exceedingly " tight," with the quartz " frozen " to the walls, but post-mineralisation movement occurred in the Odumase channel with development of carbonaceous (" graphitic ") gouge and slips. The most persistent fissures are the Odumase and Akyenase, the former being the widest and strongest. The Zongo channel is a persistent feature, but appears to have been an original fissure in the neighbourhood of which a strong strike fault developed. The Awere reef occupies a fracture of very limited extent compared with the above, and the fissure is not traceable outside the limits of the quartz lens. The existence of a zone of cross-fracturing at the south-west end of the main fracture, and not folding, is probably responsible for the sharp turns in the reef at its south-western end.

Apart from the Zongo channel there are several zones of " graphitic " gouge of varying width, some of which may be post-mineralisation strike-faults developed in the less competent beds.

Higher-temperature conditions of deposition than usual for the Gold Coast are indicated by the relatively higher degree of metamorphism of the wall-rocks, the presence of pyrrhotite in appreciable amount, and the absence or scarcity of galena and sphalerite; tourmaline has been regarded as an additional indicator, but this mineral may be post-mineralisation in age.

Acidic intrusions occur, so far of small size, but will probably increase in number and size at greater depth. A series of them occurs at the horizon of the Awere reef in the South-West Section, but cannot be said to be in the Awere channel, since that does not exist so far south. They appear to have given rise to some wall-rock mineralisation similar to that in and near the reefs, and they suggest the origin of the mineralising solutions from a granite magma.

Lyndhurst Deep Level (Gold and Silver) Ltd.

This company, in addition to its large interest in Konongo Gold Mines, Ltd., holds the northern half of Boabedroo concession, and the whole of the Attunsu, Occomadesia, Odumase, Odumase Extension No. 1, Bomfa and Manfrum concessions (see Fig. 1). This company prospected the Boabedroo concession between 1920 and

1930, and in 1933 sponsored the formation of Konongo Gold Mines, Ltd., and sold to that company the southern half of Boabedroo. At the same time prospecting of the remaining concessions was renewed, particularly Attunsu, Occomadesia, Odumase and Bomfa. In 1935 a geophysical survey over a length of 11¼ miles and a width of 1,800 ft., from the Bomfa concession to Attunsu, was carried out by a Swedish company using electrical methods. In August 1935, diamond drilling was commenced on Boabedroo concession, 21 holes being put down in all. Eleven holes were put down on the strike of the Odumase reef, and it was stated that an ore-shoot was indicated at a depth of 200 ft., having a length of 600 ft. and value of 5·5 dwt. over 30 in. Previous prospecting on a quartz vein at the surface had proved a length of 350 ft. averaging 9 dwt. over 43 in. In 1936 diamond drilling on the Odumase strike at Attunsu, and on the strike of the Akyenase reef on Occomadesia, met with little success. A striking feature of the bore cores from Boabedroo and Attunsu was the abundance of pyrrhotite, which in many cores, or parts of cores, was more abundant than pyrite.

In 1935 underground work at Attunsu and prospecting at Bomfa were suspended, results having been discouraging, and from 1936 onwards operations were concentrated at Boabedroo and at the Zongo shaft workings in Odumasi village. Development at Boabedroo continued until the outbreak of war, but ceased at Zongo at the end of 1937, to await exploration of the ground by drives from the Konongo mine workings.

The company's ore reserves stand at 158,264 tons averaging 7·2 dwt. per ton, of which 17,034 tons of 9·8 dwt. ore are in the Zongo reef, and the rest at Boabedroo.

Boabedroo.—This ore-body is situated on the strike of the Odumase reef and is probably in the same channel. There is a main shaft, 4,500 ft. north-east of the Odumase shaft, with four levels at 174, 274, 401 and 521 ft. respectively, and a small ventilation shaft to the north-east. Development on No. 4 level was not complete when operations were suspended at the outbreak of war.

The ore-body consists of a main lens and a smaller but richer lens to the north-east. The main lens increases in length and width from No. 1 down to No. 3 level, and the average value decreases somewhat. On No. 3 level it is a very strong body of quartz over 1,200 ft. in length, with a value of between 6 and 7 dwt. over a width of some 90 in. The smaller lens increases slightly in length from No. 1 level downwards. On No. 2 level it is 215 ft. long and averages 9·9 dwt. over 52 in., whereas on No. 3 level it is 255 ft. in length and carries a somewhat higher value. It appears to be pitching steeply to south-west, in vertical section.

The channel presents many general similarities to the Odumase channel and the structural features, such as faulting and jointing, follow similar directions to those in Konongo mine.

Zongo.—Up to the end of 1937, when operations at this shaft in

Odumasi village were suspended, two levels and a prospect level had been driven, and ore reserves stood at 17,034 tons of an average value of 9·8 dwt. per ton.

The workings lie immediately to the south-west of those at Konongo and are in the Zongo channel, which persists right through Konongo mine. The reef here was originally a strong body of quartz, situated in a fissure in carbonaceous schists with a thin bed of gondite, immediately on the foot-wall side of a bed of calc-chlorite-schist. Post-mineralisation movement, which appears to have been repeated at intervals, was more pronounced in this channel than in any other part of the mineralised zone, with the result that the wall rocks of the fissure have been mashed up over a width of some 50 ft. into a carbonaceous gouge, and the quartz body broken up into discontinuous crushed lenses.

On No. 2 level a cross-cut was driven to the south-east in an endeavour to locate the Akyenase fissure. A reef was intersected at a distance of 116 ft. from the drive. Driving to the north-east on this reef gave poor values, while that to south-west opened up 84 ft. of ore averaging 6·2 dwt. over a width of 52 in. It is unlikely that this is the Akyenase fissure, which in Konongo mine is about 230 ft. from the Zongo channel.

The quartz in this channel, both here and at Konongo, is characteristically dark grey, almost black in colour.

Development was stopped to await exploration by drives from Konongo mine, but so far this has not been carried out.

Attunsu.—Prospecting on this concession in 1933-34 located a reef (Smith's reef), which near the surface was said to contain good values for a length of 250 ft., over a width of 30 in. Exploratory work at a depth of 200 ft. found no indications of the reef at that depth. Diamond drilling in 1936 also met with little success.

Nanwa Gold Mines, Ltd.

The old Obenemasi mine, situated 5 miles in a direct line north-east of Konongo mine, and now owned by Nanwa Gold Mines, Ltd., was worked in the early years of the present century, when a small three-compartment shaft was sunk and four levels were driven. Operations ceased in 1907, after a small production.[1]

The present company reopened these workings, which lie about 1,500 ft. from the Birrimian-Tarkwaian boundary to the east, and prospected the concession in general by means of pits, trenches and adits, especially the ground west of the Tarkwaian boundary. Eventually a new shaft was sunk some distance to the north-east of the old workings, at a point 1,300 ft. west of the Tarkwaian boundary.

Development at the old shaft proved disappointing and was suspended. At the new shaft promising results led to the concentration of all operations at this shaft and in prospecting to locate possible extensions of the mineralised zone to south-west and north-east. Up to the outbreak of war, when the mine was put on a care and maintenance basis, development had been carried down to No. 4 level, with indications of a large, disseminated sulphide ore-body, and fairly promising results had also been obtained by trenching across the strike to the north-east.

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[1] *Mem. No. 4, Geol. Surv. Gold Coast,* 1935, p. 36.

Old workings.—The main work done here was to sink a winze 112 ft. below the old No. 4 level and drive No. 5 level, with an intermediate drive at 50 ft. below No. 4.

No clearly defined and strong fissure exists in these workings, and the ore-body consists of short lenses of auriferous quartz, 18-24 in. wide, occurring at intervals along a strike of several hundred feet and throwing off branches of limited extent to east or west along cross fractures. The lenses are separated along the strike by stretches of mineralised country rock with nothing but a few stringers of quartz. Not all the lenses are on the same horizon, and one may pinch out and a second commence some distance away in the foot- or hanging-wall. The auriferous quartz, which is dark blue-grey in colour, is heavily intruded by barren white quartz, and on some drives this is more abundant than the auriferous quartz. The country rocks are dark carbonaceous schists, and indurated phyllites interbedded with greenstones and calc-chlorite-schists. The quartz veins are enclosed in the carbonaceous schists, which are heavily mineralised with pyrite and arsenopyrite, and the quartz also contains sulphides and a good deal of ankerite.

New Workings.—The new shaft here was originally sunk on the strength of some values found in pits. At 172 ft. a cross-cut from the shaft located a wide mineralised zone consisting of veins and stringers of quartz in heavily mineralised country rock. Attention was at first concentrated on the exploration of a prominent quartz vein in this zone, but subsequently the shaft cross-cut intersected a narrow " graphitic " channel, which was then driven on to north-east and south-west. On No. 1 level the wall-rocks were reported to average 8 dwt. over 122 in. for a length of 240 ft. The shaft was sunk to No. 2 level at 300 ft., and the fissure located and driven on. Sampling of this level is reported to have originally given a value of 6·1 dwt. over 186 in. for a length of 1,650 ft. After the discovery of persistence of values to Nos. 3 and 4 levels, No. 2 level was further extended in values. Nos. 3 and 4 levels were reached by winzing from No. 2 level to depths of 425 and 525 ft. from surface respectively. It is now known that the ore-body has a strong north-easterly pitch, and consequently values were poor when the fissure was first encountered on Nos. 3 and 4 levels.

The values occur in a highly carbonated grey rock crowded with acicular crystals of arsenopyrite and also containing some pyrite and pyrrhotite. The rock is so metamorphosed that its original nature is difficult to determine, but it is in all probability a tuff. It occurs in contact with a greenish calc-chlorite-schist which is probably a metamorphosed basic lava. This rock contains only a little sulphide. The country rocks are mainly dark phyllites and carbonaceous schists, sometimes heavily mineralised with sulphides. They dip very steeply to W.N.W. or E.S.E.

The "graphitic" fissure, which varies in width from a few inches to about two feet, is used only as a guide to development. There are no values in it, or in the white quartz which occurs in it in places. The ore is located by cross-cutting at short intervals, or by diamond drilling. It swings from one side of the fissure to the other and may sometimes be a considerable distance away from it, for instance, when it traverses the greenstone or calc-chlorite-schist, which is barren. In one part of the mine the fissure dips steeply to north-west, in another part to south-east and in yet another it is vertical. Its general strike is N.N.E., but at the south end it swings to almost N.-S. and seems to be resuming the normal strike further south again. Dips are very steep to vertical.

As stated above, the country rocks, except the calc-chlorite-schist, are in places strongly impregnated with sulphides and carry veins and veinlets of quartz, some of which carry values, and veinlets of carbonate. Biotite is sometimes strongly developed, particularly in the neighbourhood of the main fissure. It seems probable that the fissure was the original main channel of mineralisation, and that the auriferous sulphidic solutions chose the tuff as a more favourable host rock than the lava. The other prominent mineralised zone in the mine, in which values are sporadic and non-persistent, resembles the David reef horizon at Konongo.

The outcrop of the ore-body was located by trenching in the highly weathered rocks at the surface. Here the values are in general lower and extend over a greater width than at depth. Systematic trenching across the line of strike has demonstrated the existence of low values over considerable widths for a distance of some 5,000 ft. to the north-east, as far as the neighbourhood of Kwakawkaw. Here the Upper Birrimian rocks pitch beneath the Tarkwaian, and the strike seems to be changing from N.N.E. to N.W., with a steep dip to the north-east.

Ashanti-Obuasi Reefs, Ltd.

This company owns the Patriensa concession, situated between the properties of Nanwa Gold Mines, Ltd., and Lyndhurst Deep Level, Ltd. In 1935 some prospecting was carried out by the Konongo company on behalf of Ashanti-Obuasi Reefs, Ltd. Attention was concentrated on the ground at and to the west of the Tarkwaian-Birrimian boundary. A quartz vein was located close to this boundary but exploration gave disappointing results. Later the company began the systematic prospecting of the concession, and the first result was the discovery of a quartz outcrop some 1,500 ft. west of the Tarkwaian. No native workings were to be found on or near this outcrop, which was named the "Abayie

Reef." It was originally tested by means of pits and trenches, over a length of some 1,300 ft., which showed a series of short discontinuous lenses restricted in depth, from some of which low values were obtained. Investigation of the occurrence at depth was also carried out from a small vertical shaft, and some diamond drilling was done. Subsequently the whole of the concession was intensively prospected by means of long trenches and pits across the whole width of the Upper Birrimian rocks of the gold belt, and lines of pits were carried across the Tarkwaian and into the eastern (Brinsem) belt of Upper Birrimian. Work was carried on up to the outbreak of war, without the location of any really promising deposit to that date.

AGE OF MINERALISATION

The question of the pre- or post-Tarkwaian age of the ore deposits in the Konongo belt is bound up with that of the age of all the other large gold-quartz veins of the Gold Coast. Junner[1] is of the opinion that the evidence in general points to the pre-Tarkwaian age of the channels, whereas Cooper[2] ascribes their formation to overthrust faulting accompanying intense post-Tarkwaian folding movements, and in his geological map of the Prestea goldfield shows part of the reef system near Prestea traversing Tarkwaian rocks. Recent detailed mapping by the Geological Survey has shown, however, that the ore channels are in Birrimian rocks close to the Birrimian-Tarkwaian boundary.

There is ample evidence near Konongo that the Birrimian rocks were uplifted, folded and intruded by granite before the deposition of the Tarkwaian sediments, and the writer believes that the auriferous ores in this district were formed during this period of orogeny. Perhaps the most conclusive evidence in support of this theory is that the Konongo gold channel ends near Kwakawkaw, where the Birrimian rocks pitch under the Tarkwaian to the north.

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[1] *Mem. Nos.* 2 *and* 4, and *Preface to Mem. No.* 3, *Geol. Surv. Gold Coast.*

[2] *Mem. No.* 3, *Geol. Surv. Gold Coast,* 1934.

ABSTRACTS AND NOTES

Obituary.—A. T. Faircloth. We deeply regret to record the death at Winchester on January 6, in his 67th year, of Mr. Arthur Thomas Faircloth, a former member of the Imperial Institute staff.

Faircloth first entered the service of the Institute in 1894 as an assistant in the laboratories, but in 1898 he joined Messrs. Henry Faija & Co., with whom he remained for 17 years, during which time he gained invaluable experience of cement manufacture and testing under the guidance of Mr. D. B. Butler, A.M.I.C.E. In 1916 he was re-engaged by the Institute as a Special Assistant for cement work, and in 1926 was promoted to the grade of Senior Assistant. He retired in 1935 on reaching the age limit and was then engaged until 1938 as a Technical Assistant by the London Advisory Committee for Rubber Research (Ceylon and Malaya).

Faircloth was one of those fortunate men whose work is their hobby. Though he had no academic qualifications he had a profound knowledge of all aspects of the subject which he had made his life work. He was, moreover, a superlative craftsman and had designed and made at the Institute several pieces of valuable apparatus including an experimental cement kiln, a machine for mechanically compacting cement-sand briquettes for testing, and a constant-humidity cupboard for briquette storage. Descriptions of the last two were published in the technical press, and a firm of technical apparatus manufacturers obtained permission to copy his design for the cupboard. While at the Institute he also did valuable work, in co-operation with other cement testers, for the British Standards Institution in connection with the revision of the standard specifications for Portland cement.

The whole of Faircloth's work was characterised by painstaking accuracy, and he was conscientious to a fault. Though handicapped by indifferent health in his later years he was always cheerful, and it was never too much trouble for him to give any help in his power to a colleague.

Those who were closely associated with him will have learnt much from his example and are fortunate if they can, in their own work, emulate his keenness and efficiency.

Search for Tungsten Ore in Canada.—The loss of Empire supplies of tungsten from Burma and Malaya has greatly enhanced the importance of numerous scheelite deposits which have recently been discovered or re-investigated in Canada. The United States has led the way in the development of scheelite resources, and is now by far the foremost producer of this mineral, and new technical developments have aided both the discovery and recovery of scheelite. Under short wave ultra-violet radiation scheelite exhibits a brilliant pale bluish fluorescence, and a portable ultra-violet lamp has been devised for use underground or on surface exposures either at night or under a suitable cover as a means of detecting the mineral. Considerable losses of tungsten frequently occur in the milling and concentration of scheelite, in part owing to the relative softness of the mineral when associated with quartz and sulphides, but improved recovery has recently been achieved in new flotation plants operating in the United States, and chemical methods of recovery and beneficiation have also been introduced with success.

The *Canadian Mining Journal* of December 1941 has reported progress in the search for tungsten ore in Canada. The scheelite frequently occurs in gold-bearing veins, though seldom in quantities sufficient to be recovered at a profit, and its production from

Canadian gold mines represents a direct contribution to the war effort on the part of the companies concerned. Using a portable ultra-violet lamp an officer of the Department of Mines and Resources has recently inspected approximately 40 gold-producing properties in the Porcupine, Kirkland Lake, and other areas in Ontario, and in the Amos and Val d'Or areas of western Quebec. To encourage the production of tungsten, high-grade scheelite concentrates from hand-picked ores are now being prepared in the ore-dressing laboratories of the Department. Although the ores are obtained mostly from gold mines in Ontario and Quebec, some fairly large shipments have come from mines in British Columbia, and a few smaller ones from the Mayo area, Yukon.

Tungsten-bearing veins discovered during the past two years in the Yellowknife-Beaulieu River area, North-west Territories, have been examined by two geologists of the Department of Mines and Resources, A. W. Joliffe and R. E. Folinsbee. Approximately half of the 4,000-square mile region is underlain by rocks in which scheelite might occur, and within these rocks 400 or more veins containing varying amounts of tungsten have already been found. So far only about 5 per cent. of the favourable ground has been carefully prospected for scheelite.

Most of the two hundred or more scheelite veins examined lie within 10 miles of Gilmour Lake, which is 45 miles east of Yellowknife settlement. None of them is sufficiently large or rich to be mined profitably for tungsten alone, but by certain alterations in the equipment of one or more of the gold milling plants in operation, or to be erected in the region, high-grade scheelite concentrates could be recovered. Some such arrangements are under consideration by the companies or syndicates concerned, and any action taken will depend largely upon assay returns from samples already collected or being collected.

Scheelite was first identified in the region in 1939 in the Con mine in veins being mined for gold, and in the following year twenty tungsten-bearing veins were discovered near Gilmour Lake. It was not until 1941, however, that concerted efforts were made to search for and develop tungsten-bearing deposits. No veins of an obviously commercial character were discovered during the 1941 season, but the many occurrences within the small area intensively prospected are a favourable indication that there may be commercial deposits in the region, and accordingly it is recommended for further careful prospecting.

During 1940 a Geological Survey party examined three tungsten deposits in Yukon, and their findings are reported in *Geological Survey Memoir* 234, " Mining Industry of Yukon 1939 and 1940." The most promising is a placer deposit at the head of Canadian Creek, a tributary of Britannia Creek which enters Yukon River about 50 miles below Fort Selkirk. The placer material is more of a residual soil than a washed gravel, and at the point examined carried about 21 lb. of wolfram (ferberite) per cu. yd. in addition to $1 to $2 and sometimes $7 in gold per cu. yd. A rough estimate made from the little information available suggests that this deposit contains 400,000 cu. yds. of ground holding 2,000 tons of ferberite. Hitherto lack of water has discouraged working in this area and placer mining is only feasible in summer when the ground thaws. In the summer of 1941, however, Canadian Tungsten Ltd. were reported to be preparing for dragline dredging for gold and tungsten in this region. Another placer deposit is known 38 miles from Mayo, in Dublin Gulch, a tributary of Haggart Creek which runs into the South Fork of McQuesten River, but it could only be worked on a small scale, perhaps at the rate of 20,000 cu. yds. a year which might yield about 10 tons of scheelite. Thin veins carrying scheelite were also found in both granite and adjacent metamorphic rocks at the head of Dublin Gulch.

In addition to the deposits described above, several occurrences of tungsten ores are known in Nova Scotia, New Brunswick, Manitoba and British Columbia. At Hardscrabble Creek, in the Cariboo mining division, B.C., the Columbia Tungstens Co., Ltd., shipped 4 tons of scheelite concentrates in 1939, this representing the first commercial shipment of tungsten concentrates in Canada for several years. Early in 1940 the Kirkpatrick Tungsten Syndicate shipped tungsten concentrates from a deposit at Goff, Halifax County, Nova Scotia. In the North-west Territories, complex gold-silver-copper-tungsten ores are being mined on Outpost Island, Slave Lake, by Slave Lake Gold Mines Ltd., and a first shipment of 20 tons of complex tungsten concentrates was exported to the United States for refining in 1941. Other developments have also taken place at the Indian Path Mines, near Lunenburg, at North Waverley, and at Lake Charlotte tungsten mines, Halifax County, all in Nova Scotia, near Guigues in Quebec, and at the Regal silver mines, Revelstoke, British Columbia.

Barytes in Canada.—Hitherto barytes has only been mined on a small scale in Canada ; after a period of six years, during which none was produced, two small mines in Ontario were working in 1939, and in 1940 about 330 short tons of barytes were shipped. In October 1940, however, a new deposit was discovered in Nova Scotia from which over 5,000 tons of barytes have already been exported, and it appears likely that Canada will now become an important source of this mineral. A note on this discovery appeared in the *Canadian Mining and Metallurgical Bulletin* of November 1941, p. 439. The deposit is near Pembroke, Hants County, and 2½ miles south-west of Walton, on Mines Bay. L. J. Weeks, a geologist of the Department of Mines and Resources, who has examined the deposit, reports that the portion of the deposit as outlined by 16 vertical diamond-drill holes has a horizontal width varying from less than 100 ft. to more than 200 ft., a thickness varying from a few feet to more than 150 ft., and a length in excess of 500 ft. He estimates that there is present, in the explored part, at least 420,000 short tons of barytes of a grade suitable to meet the specific gravity and other specifications set by the Trinidad oil companies which are likely to provide the chief outlet for the ground product. Additional estimated reserves of 321,000 short tons are also probably within the required specifications. A mill capable of treating 150 tons of ore a day, or about 45,000 tons a year, has been erected at Walton where there is a wharf for shipping the material. The first exports consisted of two cargoes of 2,500 tons each consigned to Trinidad for use in the drilling of oil wells, and a smaller consignment of 250 tons shipped to Peru. The barytes was ground to the requirements of the Trinidad purchaser —98 per cent. finely ground, 325 mesh, having a specific gravity of 4·3 to 4·4. Although it is said to be discoloured, the barytes will be bleached for sale to the paint industry.

The Jeffrey Asbestos Mine.—An account of operations at what is claimed to be the world's largest asbestos mine appeared in the September, October and November issues of *Engineering and Mining Journal*, 1941.

The Jeffrey mine is situated at Asbestos, about 115 miles northeast of Montreal, Canada. Operations were commenced here in 1881 by W. H. Jeffrey, a wealthy farmer; in 1916 the mine was purchased by T. F. Manville from the Asbestos & Asbestic Co., and in 1918 it passed to its present owners, Canadian Johns-Manville Co., Ltd. The present output is about 6,000 tons of chrysotile-bearing rock daily, and after separation in the milling plant, part of the fibre produced is utilised in the Company's plant in Asbestos and part is exported.

Asbestos-mining operations must be directed towards producing so far as possible the grade of fibre in demand, and close engineering control has to be maintained by inspection of diamond-drill hole data, records of mined-out areas, daily records of visual examination of ore in mine and mill, and the detailed mill report. The pit is worked opencast in 35 ft. benches, but recently an extensive drilling campaign has been carried out to provide data for a possible extension of operations underground. All blasting is electric, and electric shovels are used for digging at the foot of the benches with I.C.E. shovels for cleaning up. Both steam and electric locomotives are used for haulage, electric power being obtained from Shawinigan Falls about 75 miles from Asbestos. Care is taken to exclude all wood from the mine to prevent its entry into manufacturing machinery or finished products.

Electric haulage is used to bring the rock to the mill, where it is first crushed in two stages to pass through 3 in. screens and then dried in rotary driers. After drying it is further crushed to ½-⅝ in. and passed over screens where any liberated fibre is removed by aspiration. The undersize is conveyed to a second mill for further treatment and the oversize is crushed to ¼ in. and aspirated over screens. The fibre so far obtained is further cleaned and processed to meet the specifications demanded of spinning and shingle fibres in groups 3 and 4, Quebec Standard Test.

The undersize from the last screens passes either to tailings storage or to the second mill where numerous grades of short open fibres are produced. The oversize passes to specially designed impact mills where the rock fragments are disintegrated by being struck while falling by hammers revolving at a tip speed of 10,000 ft. per minute on a vertical shaft.

The harsh fibre so far collected has not been greatly broken or fluffed out and is passed over double-deck screens with a lower deck of 20 mesh without aspiration. The fibre passing through is used for making asbestos tiles or other products requiring group 7 fibres. The middle- and over-size fibres are separately screened, aspirated and passed into cyclone collectors, where group 4 shingle fibre and group 3 spinning fibre are obtained respectively from the longer fibres, the rejects passing to the other mill for further treatment. These harsh fibres constitute about 25 per cent. of the total fibre.

Material from the impact mills is fed to double-deck screens where fibre is aspirated from the top deck, rejected material from this deck being a middling sent for further treatment while tailings pass to storage. The next step is to collect "open" or fluffed-out asbestos fibre. The aspirated fibre is collected into cyclone collectors and then dropped on to cleaning screens. Undersize from these and all subsequent screens are used to produce group 7 fibres or group 8 sands. The aspirated fibre from these screens passes first into cyclone collectors and thence to double-deck screens, and after passing a further series of cleaning screens and cyclone collectors, into graders where the fibre is classified into groups 4, 5 and 6.

The cyclone collectors are exhausted into float chambers and thence into float sheds where the material settles out and is conveyed as required to the cement plant. Any dust which does not settle is precipitated in a Cottrell plant and is used in cements or plastics or is rejected as tailings.

Mineral Resources of Manica and Sofala, Portuguese East Africa.— The district known as the Government of Manica and Sofala occupies the country lying between the Zambesi on the north and the 22nd degree of south latitude on the south and is the territory covered by the charter granted to the Mozambique Company which expired in 1941. The charter covered an area of 65,000 square miles and was analogous to that granted by the British Government to the British South Africa Company.

Although it is now 50 years since the Portuguese Government granted the charter and over 30 years since a mineral survey was established, comparatively little interest in the mineral resources of the territory has been taken by the outside world.

The following notes are taken from a review of the mineral resources of the area by Dr. L. L. Colin, Metallurgist of the Mines Department of Portuguese East Africa (*S. Afr. Min. Engng. J.*, December 27, 1941, pp. 489-492) which is based on records and data placed at his disposal by Dr. P. de Carvalho, Director of Mines at Macequece.

Sofala was discovered in 1500 by Sancho de Toar, but evidence from old gold workings indicates that the area had been occupied about 1000 B.C., probably by an Arabic race. It is also possible that the Greeks and Romans obtained gold from this area. In general, the ancient workers confined themselves to alluvial operations, but a few reef workings are known. In no instance, however, was any attempt made to work the deposits below water level.

A geological survey report on this area was made for the Mozambique Company by Freire de Andrade, Director of Mines in 1900, but it was not until 1911 that a mineral survey was established with the object of making a comprehensive examination of the mineral resources of the area.

The principal mineralised zone is an area around Macequece on the Rhodesia border which consists of archæan talcose chloritic and hornblende schists with granite on both the northern and southern flanks of the area. Granite and felsite as well as diorite, diabase and other basic igneous rocks also occur in the schistose area.

Gold is the principal mineral produced in the territory, £1,099,246 worth having been produced between 1903 and 1938. As elsewhere in the world, the increased value of gold has had a marked effect on production, which has risen from 176 oz. in 1930 to 8,988 oz. in 1938 and to 12,526 oz. in 1940.

Alluvial gold is found chiefly in the Revue and Chua rivers of Manica where dredging has been successfully carried out for a number of years. Gold in small quantities occurs in many streams and rivers of Moribane and Mossurize and is believed to indicate the presence of reefs in the frontier mountain chain from which they flow. The rocky nature and steep grade of the streams, however, makes them unsuitable for large-scale methods of exploitation.

In the neighbourhood of Bandiri, gold occurs in decomposed quartz mica schist which is associated with biotite gneiss. The tenor of these surface or residual deposits averages only 10 grains per ton, but they can nevertheless be profitably worked owing to the physical state of the rock in which the gold occurs. In the reef deposits the gold is not confined to the quartz reefs themselves, but is also found in the schist walls. In the Manica district visible gold can be found in quartz in some places, whilst in others the gold occurs as a fine dissemination. The values, therefore, are erratic and vary from traces up to 1 oz. per ton. In the Tete district contact gold deposits are known but they are almost invariably very low grade. As in the neighbouring territory of Southern Rhodesia, the properties are operated by small workers with simple mining and crushing equipment followed by amalgamation, although flotation and cyanidation are employed in one or two instances. Nearly all the mining, therefore, is on free-milling ore and this is largely obtained from the outcrops. In few cases has mining been carried to depth.

Copper has been found at two places in the Manica district, one at the junction of the Rivers Lundi and Save (Sabi) and another on the Serra Isitaca. The latter produced 250,000 tons of copper before 1921 when all the ore in sight was worked out. No copper is being produced at present.

Tin occurs sometimes in association with wolframite in pegmatites, gneisses or mica schists at Inchope in the Chimoio district. Alluvial tin is also known in this district but its extent has not been ascertained. Mining of the tin is on a restricted scale, the output exported in 1940 being only 13 tons.

Bauxite of high quality occurs to the north-east of Mount Shuta in the Manica district. The best white grade shows a minimum of 60 per cent. Al_2O_3 and a maximum Fe_2O_3 content of 3 per cent. The deposit is worked for the Wankie Colliery Co. Ltd. of Southern Rhodesia, who manufacture high-quality alumina refractory firebricks.

Coal lying at a depth of only 20 ft. occurs near the Zambesi below the River Moatize. It is of good quality having a content of from 4 to 16 per cent. ash and about 22 per cent. volatiles. It is estimated that reserves of the order of a hundred million tons are available. Coal has also been found in the Mamoice district just below the dry bed of the Mpotepote stream. The occurrence is undoubtedly part of the Sabi River coal basin of Southern Rhodesia.

Graphite has been found at Angonia in the Tete district and a deposit containing 11·67 per cent. crystalline graphite is known in the Mpunga district. At Gorongosa, on the River Mhamuo, samples of graphite have been obtained which on analysis gave 13·71 per cent. graphite.

Iron.—In the Milange (Mlanje) district on the Nyasaland border a large deposit of high-grade haematite ore has been proved. Analyses have shown an average of 70 per cent. total iron and a silica content of 0·22 per cent. It has been estimated that about 80 million tons of ore exist in this deposit.

Scheelite and *wolframite* are also known in this territory, the first of these being found in many of the gold reefs. Molybdenite and lead are also known, but not in quantities of economic interest.

Uses of the Precious Metals.—The 1941 Streatfeild Memorial Lecture of the Institute of Chemistry, which was recently delivered by H. Gordon Dale, was devoted to the subject of the precious metals. The main body of the paper is concerned with the detailed technology of the sampling, separation and refining of jewellers' "sweep" and other precious salvage, but it also deals with the principal uses of the precious metals in industry.

The precious metals are gold, silver, platinum, palladium, iridium, rhodium, ruthenium and osmium, and most of them are characterised not only by high resistance to atmospheric corrosion and to attack by acids and alkalies, but also in the case of the platinum metals by high melting points. In the case of silver, however, the resistance to attack by an atmosphere containing sulphur is comparatively low.

The metals included in this group (except silver) vary in price from 112*s.* 6*d.* per oz. for palladium up to £35 per oz. for rhodium, so that only relatively small amounts of these metals are used in industry. The notable exception to this, of course, is silver, which, at a price of about 2*s.* per oz., is used in very considerable amounts in industry.

The following table shows very roughly the variations in price of the precious metals during the past ten years—a very important consideration for all those dealing in any way with these metals.

Prices per Ounce Troy.

Year.	Gold.	Silver.	Platinum.	Palladium.	Iridium.	Rhodium.	Ruthenium.	Osmium.
1931	85/-	1/2	97/-	80/-	225/-	140/-	130/-	200/-
1932	109/-	1/7	185/-	80/-	225/-	206/-	140/-	200/-
1933	120/6	1/7	127/6	77/6	127/-	220/-	120/-	200/-
1934	135/6	1/10	130/-	85/-	170/-	180/-	125/-	180/-
1935	145/1	2/7	120/-	85/-	170/-	160/-	140/-	120/-
1936	140/6	1/10	118/-	85/-	190/-	180/-	120/-	100/-
1937	142/-	1/10	215/-	90/-	460/-	350/-	120/-	135/-
1938	140/-	1/8	120/-	90/-	240/-	520/-	120/-	120/-
1939	148/6	1/9	122/6	95/-	210/-	540/-	120/-	120/-
1940	168/-	1/10	165/-	100/-	800/-	600/-	145/-	160/-
1941	168/-	2/-	170/-	112/6	600/-	700/-	150/-	160/-

Prior to 1920, standard silver, which is 925 fine, was used for coinage, and this was the principal use in Great Britain. In 1920 and 1921, coinage alloy contained 50 per cent. silver, 40 per cent. copper and 10 per cent. nickel. This proved unsatisfactory from a metallurgical point of view, and from 1923 to 1927 an alloy of 50 per cent. silver and 50 per cent. copper was used. Since 1927, silver coinage has consisted of 50 per cent. silver, 40 per cent. copper, 5 per cent. nickel and 5 per cent. zinc.

Second in importance to the use of silver in coinage is the utilisation of the metal as silver nitrate in the photographic industry. For this purpose, lead is a highly objectionable impurity, and the silver used must not contain more than 1 part in 50,000 of lead. To attain this purity, silver of 999·85 fine is specially prepared by using fine silver bars and sheets as the anodes and cathodes respectively in an otherwise normal process of electrolytic refining. By this same means, it is interesting to note, silver containing less than 1 part in a million of lead, as well as spectrographically pure silver for use in the poles of spectrographs, has been produced.

The silver-plating industry also uses high-quality electrolytic silver since impurities tend to set up local currents causing bad plating as well as to form slimes. Silver for this purpose is melted in graphite or carborundum pots containing about 1,200 oz., after which it is cast into flat iron moulds and rolled into sheets.

The silver jewellery trade largely uses standard silver of 925 fine which meets the requirements for hall-marking, but in modern practice, silver of 926 fine is usually supplied to silversmiths so that instances of silver goods being found below standard and being broken up by the assay offices, are now very rare. The principal alloying constituent in jewellery-silver is copper and occasionally cadmium.

Considerable quantities of silver are now used in the manufacture of silver solders, and there are a number of British Standard specifications for such solders which incorporate copper, zinc and cadmium. Other solders are manufactured to different specifications for special purposes.

In the foodstuffs industries, silver is extensively used in evaporating basins, condenser tubing and similar plant.

Gold alloys incorporating copper or silver, are made in four standard grades of 22, 18, 14 and 9 carat, but lower grades than these used for cheaper ware cannot be hall-marked. White gold, so called, is made by introducing either nickel or palladium into the gold alloys. Of these, the nickel alloys are harder and more difficult to work, but they give a better platinum colour and are cheaper to produce.

Platinum is manufactured in sheet and wire form for use in the electrical and chemical industries owing to its high resistance to atmospheric corrosion and to attack by acids. Platinum melts at about 1760° C., so that smelting operations are usually carried out either in a high-frequency electric furnace or under an oxy-hydrogen blowpipe. Platinum is rather a soft metal, and it may be hardened by the addition of iridium or iridium metals commonly up to 25 per cent. for use, for example, in electrical contacts. The alloy used by jewellers commonly consists of 95 per cent. platinum and 5 per cent. copper, and that by dentists, 30 per cent. platinum and 70 per cent. silver. Platinum and platinum-rhodium gauze is used as a catalyst in the manufacture of sulphuric acid from sulphur dioxide and platinised asbestos is in use for similar purposes.

Rhodium is used as a 10 or 13 per cent. addition to platinum in high-temperature thermocouples in which one wire is the rhodium-platinum alloy and the other pure platinum. Highly pure metals are necessary for this purpose, and spectroscopic examination is employed in order to keep up the requisite standards.

Iridium, as mentioned above, is chiefly used for hardening platinum, and the principal application of ruthenium and osmium is in the production of alloys for making hard points for fountain pens.

Minerals for the Paint Industry.—A paper on this subject by S. J. Johnstone, Principal of the Mineral Resources Department, Imperial Institute, in the *Journal of the Oil and Colour Chemists' Association* (November 1941, pp. 263-287), gives some useful information about new sources of supply and substitutes which have been developed to meet war-time conditions.

In order to replace the 40,000 to 50,000 tons of barytes formerly imported from Germany, Italy and Greece, production in the United Kingdom has greatly increased, the new mines which have been opened or are developing in the North of England having a total capacity of at least 50,000 tons a year. Finely ground Cornish china-stone is also being marketed as a substitute for barytes under the name of "Kalytes." Bentonite has come into use in the paint industry in recent years as a suspending and flatting agent, but as supplies from the United States are now controlled and the Canadian deposits are as yet almost unworked, domestic substitutes are being developed. Fuller's earth, which like bentonite consists essentially of montmorillonite, is worked extensively in England and several products are prepared by the Fuller's Earth Union, Ltd., for the paint industry. One is known as "Union Bentonite No. 1," which swells in water, although more slowly than American bentonite, and another, known as "Fullogel No. 1," is a gel of the aluminium hydroxide type which forms a thixotropic gel in water and can be used in the preparation of bituminous emulsions. Natural fuller's earth is also used, and is claimed to be superior to German green earth as a base for lake colours.

Great Britain is fortunate in having in Cornwall and Devon large resources of high-grade china-clay from which several products are prepared for the paint industry. "Supreme" kaolin has a very smooth texture and it is guaranteed that 70 per cent. of the particles are not above 1 micron in size; another grade, known as "Speswhite," has 50 per cent. of its particles not greater than 1 micron. A mixture of "Speswhite" and white Indian talc is sold for use as a suspender under the name of "Talcolin No. 1" to replace imported fibrous talc or asbestine. Where a material of low oil absorption is required there is available a specially prepared product known as "Talcolite."

Wet-ground mica is used in the United States as an extender, and it is suggested that the "waste" mica produced in several Empire countries should be suitable for grinding for use in paint, or possibly the mica by-product obtained during the washing and settling of china-clay might be used for this purpose. Talc is in short supply owing to the loss of imports from France, Italy, Norway and Manchuria, but Empire supplies are available in India and Canada and domestic material is now being produced. The latter is quarried near Portsoy, in Banffshire, where impure talc occurs in lenticular veins in serpentine. The principal grade sold is greenish-grey in colour, but smaller quantities of off-white and pure white talc are also produced. Welsh and Cornish slate powder make useful fillers and extenders, particularly for camouflage paints.

Several natural mineral pigments are produced in the West of England. Among these are Bideford Black, a fine carbonaceous material found in North Devon, the micaceous haematite which occurs in the Dartmoor Granite near Bovey Tracey, and ochres, umbers and sienna substitutes which are produced in considerable quantities in the counties of Gloucester, Somerset, Devon and Cornwall.

Selected red haematite from the iron mines of N.W. England and Glamorgan also forms a useful pigment. Of the Empire pigments South African yellow ochre and Cyprus umber are widely used in Britain.

The Empire provides the raw materials for the important white pigments, white lead, zinc white, lithopone and titanium white, and also supplies ores and metals from which coloured pigments are obtained by chemical treatment, although at present these uses may be restricted if the metals are required for the armaments industry. Canada and Australia supply cadmium which gives fine yellows (cadmium sulphide) and cadmium lithopone. Chrome ore, which in addition to the ordinary chrome yellows yields lemon, orange, red and green pigments, is produced in Southern Rhodesia, Baluchistan and the Transvaal. Cobalt, from which blue pigments as well as important drying agents for paints and varnishes are made, is produced in Northern Rhodesia and Canada.

The hope is expressed that paint makers in the United Kingdom will try to use more home produced mineral pigments after the war than they did formerly and the suggestion is made that mineral producers on their part might pay greater attention to proper dressing and preparation of their raw products in order to make them more acceptable to the paint maker; both could be assisted by the modification of standard specifications.

BOOK REVIEWS

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SOIL MECHANICS. By Dimitri P. Krynine. Pp. x + 451, 9 × 6. (New York and London: McGraw-Hill Book Company, Inc., 1941.) Price 35*s*.

Soil mechanics is a branch of engineering science which deals with the stresses and strains in " earth masses," this being a purely conventional term covering both natural and artificially-laid bodies of earth or rock material. The practical importance of this science is, of course, obvious to all, for it is concerned among other things with the stability or settlement of foundations (whether they be for structural or highway purposes), of retaining walls, and of railway and road embankments. Yet it is only in comparatively recent years that the subject has been given the detailed and scientific attention that it deserves; and the present work is one of the few comprehensive and up-to-date relevant texts that have so far appeared in English.

An earth mass is visualised in soil mechanics as an actual physical entity; hence the necessity of studying its physical properties. This is done in Part 1 of the text under the general heading of " elements of soil physics," which consists of three chapters devoted to the origin and general characteristics of soils; soil moisture, soil plasticity and consistency; seepage phenomena and frost action in soils. The theoretical discussion of stresses and strains in such masses is taken up in the following three chapters forming the subject matter of Part 2; in view of the fact, however, that the mathematical data relating to behaviour-under-load experiments are evaluated only from so-called idealised earth masses, the difference between idealised and actual earth masses is naturally emphasised, while an attempt is made to establish some sharp line of demarcation between the two.

The third and final part of the work is a discussion ot the engineering use of the principles advanced in the previous parts, and consequently deals with that branch of knowledge known as " applied soil mechanics." Problems relating to the stability of foundations, cuts, embankments, retaining walls and bulkheads are discussed in detail in the first three chapters of this section. The remaining two chapters (Chaps. XI and XII) on settlement of structures, and soil sampling and field soil testing, conclude the work which is excellently produced, well annotated, and illustrated by no fewer than 314 figures.

The work will no doubt prove stimulating to civil engineering students, and to those civil engineers in practice—whether designers, construction or maintenance engineers—who wish to have a general outlook on the present state of this branch of engineering knowledge.

METHODS OF STUDY OF SEDIMENTS. By W. H. Twenhofel and S. A. Tyler. Pp. vii + 183, 9 × 6. (New York and London: McGraw-Hill Book Company Inc., 1941.) Price 14*s*.

This book is essentially a critical survey of the more important techniques used in the study of mineral sediments. The authors, in common with many other workers in the science of sedimentology, have long wished that the more useful sedimentary techniques might be assembled in a single work and the value of the results appraised: to this end the manuscript of the present work was started more than ten years ago, though many vicissitudes delayed its final completion and publication.

Following a brief introduction in which, however, an elaborate " flow-sheet " for the study of sediments is given, comes a discussion of the investigation of clastic rocks in the field, the discussion centring largely around a detailed schedule of "collection data" in order to ensure complete coverage of possible observations. Two chapters now follow in logical order dealing respectively with the collection of samples and their preparation for mineralogical analysis, attention here being given to the various types of samplers which are available, as well as to the best methods of sample splitting, crushing, disintegration, and preliminary chemical treatment.

At this point the subject matter of the book turns to the mechanical analysis of sediments, the underlying principle for the choice of any specific technique for this purpose being regarded as resting solely on the particle size of the material under investigation. Sediments composed of particles with diameters greater than $\frac{1}{16}$ mm. are considered best separated by means of sieves, while those made up of smaller particles are best analysed by water or air elutriators (such as the Haultain infrasizer) or by the various methods of sedimentation. The determination of grain-size by means of the microscope is deprecated, as only small samples can be investigated by this means. The authors rightly conclude this section on a note of extreme caution regarding the interpretation of mechanical analyses in terms of geological significance.

Most of the well-known methods for the separation of specific minerals in sediments are discussed in a separate chapter of 30 pages. The methods described include the use of heavy liquids and melts; centrifuges; dielectric, electrostatic and magnetic devices; panning; rolling; sieving; and hand-picking. The procedure advocated elsewhere by the junior author for separating inclusions from enclosing minerals is summarized in 24 lines.

Two chapters now follow on the quantitative determination of minerals in sediments and the application of statistical methods for their graphical representation and interpretation. Various chemical methods of mineral separation are outlined in the next chapter, which in turn is succeeded by one dealing with the physical characteristics of sediments, including their roundness and sphericity, specific gravity, permeability, and porosity.

The study of coal is discussed in the penultimate chapter from the points of view of degree of bituminization, extent of development of fixed carbon, and identification of plant constituents. The work concludes with some practical advice regarding the mounting of mineral grains, and the preparation of thin sections and nitro-cellulose peels.

The work will undoubtedly serve as a valuable supplement or appendix to the standard text-books dealing more particularly with the descriptive characteristics of mineral sediments. Those, however, who are familiar with the authors' previous exhaustive works will regret that the present volume is of a somewhat cursory nature, and lacks the completeness of detail which one has grown accustomed to expect.

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EXHIBITION GALLERIES, FILM LIBRARY AND CINEMA

THE CENTRAL FILM LIBRARY

A WORD TO BORROWERS

By W. Farr, B.A. (Oxon.),
Secretary, Central Film Library

Any Film Library at any time is bound to have plenty of problems. War-time conditions have increased the problems and at the same time increased the demand for films. The more films you have the more films you despatch, and the more problems you have. There seems no way of avoiding this. You do not complain —not that it would do any good if you did—because it means the Library is doing its job. But it may be worth describing some of the problems to people who borrow films because they can reduce the problems and thereby help the Library to give borrowers better service.

The Central Film Library embraces the pre-war Empire and G.P.O. Film Libraries and the Ministry of Information Library. The Library has a very large quantity of 35 mm. and 16 mm. sound films, a large quantity of 16 mm. silent films and small and diminishing quantities of 35 mm. silent and 9·5 mm. silent films. There are now in the Library 11,000 copies of 720 different films. There are 2,500 copies of 450 different Empire films (including films about England); 600 copies of 60 G.P.O. films; and 8,000 copies of 210 films produced by the Ministry of Information or acquired by it. There are now some 6,000 organisations and individuals, civilian and military, borrowing films from the Library, some only occasionally, but most of them at regular intervals.

You will see that on an average the Library holds six copies of each Empire film, ten of each G.P.O., and forty of each Ministry of Information film. The Library is trying to maintain and increase the number of copies of the best films in the Empire and G.P.O. sections. But this is not at all easy. The negatives of many of the Empire films are in the country of origin, and it is difficult to get copies of films from Australia and Canada in these days. Then the 16 mm. printing laboratories are taxed far beyond their capacity to meet the urgent demands of the Services and of the Ministry of Information and, important as it is to maintain the supply of educational films, it is impossible not to allow the greater importance of training films for the Services, films on diphtheria immunisation and fire-fighting, or films about the war for showing to factory workers. For these reasons it is not possible to increase the number of copies of many of the pre-war Empire and G.P.O. films to the extent that would meet the increased demand for them. While this is so it is inevitable that all the copies of many of the films should be fully booked for months ahead, and very difficult for the Library to book specific films for specific dates. This also applies to many of the most popular Ministry of Information films. There are, for example, 400 A.T.C. squadrons borrowing films from the Library, so you cannot be surprised if it is difficult to book films about the R.A.F., especially if you apply a week before your show.

Borrowers could do a great deal here to help themselves and the Library. You should always apply as much in advance as possible and never less than two weeks. If you can, apply for films for a regular day or days for several months in advance. Whenever you can, give the Library as much choice as possible. Let the Library know how many films or how long a programme you want (but not exceeding 60-70 minutes) and what types of films you want on each date rather than specific titles. On the other hand, when you want specific films and no other on certain dates, make this quite clear in your application. Where there are several connected organisations borrowing films they should co-ordinate their requests so that, for example, a school does not apply for *Into the Blue* for the 19th and the School A.T.C. for the 26th where they could arrange for it to be shown to both audiences on consecutive days. Similarly organisations or individuals who lend their projectors would help the Library if they would try to co-ordinate the film bookings of those to whom they lend their projectors.

To ensure that films reach borrowers on the day they are promised the Library has now to despatch films four or five days in advance of the booking date and to allow the same number of days for return. It is obvious, therefore, that it is more economical for the Library to book films for showing on three or four consecutive nights to different audiences than to send the films out on three or four separate occasions.

This leads me to a number of points on despatch and return of films. Films are always despatched, as I have said, four or five days in advance, unless films are not in because some borrower has failed to return them promptly or has returned them damaged. If every borrower returned films immediately after the day or last day set out on the booking sheet sent to him, the Library's problems would be halved. They would be further decreased if all borrowers returned the films in the tins and boxes in which they are despatched. Receiving back *Merchant Seaman* in the tin labelled *Night Mail*, inside the box marked *Romantic India* wastes much valuable time. Often the confusion does not end there for the Library receives back films in another Library's containers or its own container with, sometimes, part of an untitled film from some other library.

There still remains the damage problem. The most efficient and careful projectionists have accidents, but most of the damage done to films is not of this kind. There is no excuse for strained or torn perforations, or scratches down to the base throughout the film, and even less for films returned with the opening titles or last 20 ft. torn off. Almost always damage of this kind means that at least two subsequent bookings have to be cancelled or some other film substituted. I wonder if borrowers realise that the cost of printing a 400 ft. reel of 16 mm. film is not less than £3. This Library and others too, I know, have had films ruined by the first borrower to whom they have been lent. There is rarely any doubt about the responsibility for the damage. Every film is carefully examined on its return from every booking before being sent out again, and while slight wear may be overlooked, gross damage is not. But do all projectionists realise that most damage is done *after* the film has passed through the gate, and is not, therefore, seen on the screen or heard during projection ?

If I end on very elementary points it is because they account for a large part of any Film Library's unnecessary work. I have already urged that borrowers should apply for films as much in advance as possible. But time is again lost, if borrowers do not state quite clearly the type of projector being used ; 16 mm. is obviously not enough ; we must know whether it is sound or silent. We must also know the exact date on which the films are to be shown (or alternative dates) and it helps us in selecting films if we know the audience for whom, or the purpose for which, the films are required. Please do not telephone to make bookings except in the most urgent circumstances ; it is most unlikely that at such short notice the Library will be able to give you much help. And, finally, when you return films promptly tie them up so that they do not come adrift in the post. There is an empty box on my desk as I write this and somewhere between here and Birmingham there is a film which ought to go out tomorrow to another borrower who particularly wants this film, and we have no other copy to send.

NOTES

Exhibition Galleries.—In the difficult circumstances of the present time the acquisition of new exhibits has become almost impossible as it is obviously inadvisable to approach manufacturers for assistance in view of their concentration on the war effort; and shipping space has become so precious that it cannot be used for the transport of exhibition material from overseas, however desirable such material may be. Meanwhile, good use is being made of the existing displays in the Galleries in disseminating visual information as to the Empire origin of many foodstuffs and raw materials of all kinds—many of them little known to the layman, but of vital importance to our war effort. That the assistance given by the Exhibition Galleries in this connection is appreciated by the Service authorities is shown by the number of troops who avail themselves of the opportunities afforded them for visits to the Galleries for conducted tours and lecture demonstrations.

During the past quarter the following organised parties, including members of H.M. Forces, have made conducted tours:

1941—

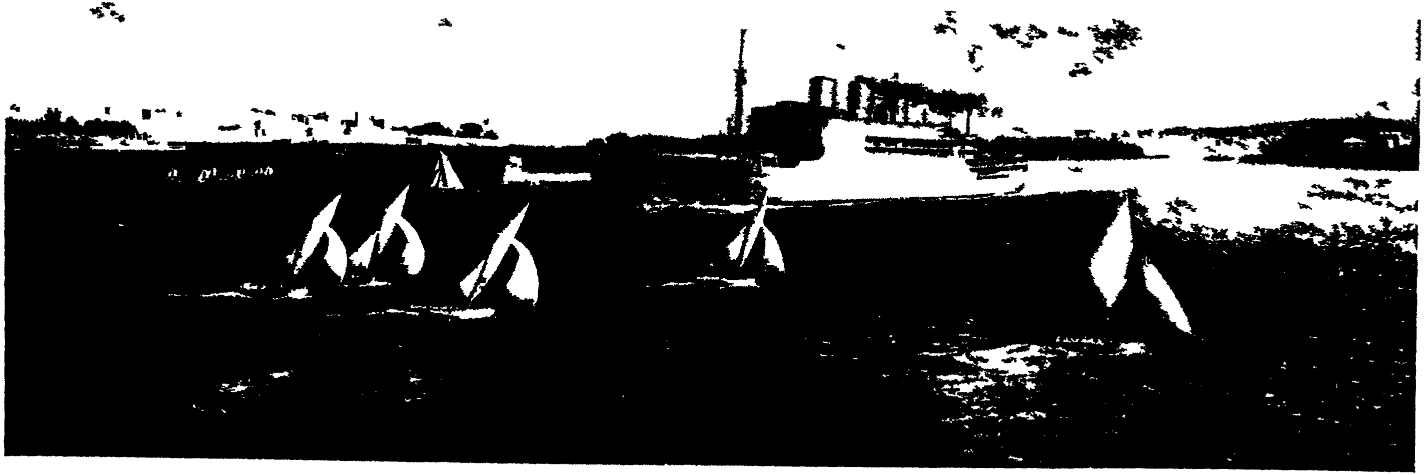
October 25—Members of the Cypriot Women's League.
November 3—A party from Leggatt's Way Senior Boys' School.
November 5—A party from Kensington High School.
November 6, 13, 20 and 27—Contingents of Indian troops.
November 7 and 21—Members of the Association of Polish Engineers.
December 3—A party from Kensington High School.
December 4, 11 and 18—Contingents of Indian troops.
December 10—A contingent of a Guards Brigade.
December 13—Members of the South London Botanical Institute.

1942—

January 1.—The 21st Hendon Boy Scouts.
January 1, 8, 15, 22 and 29.—Contingents of Indian troops.
January 12 and 13.—A contingent of an Anti-Tank Battery.
January 17—Members of the London Appreciation Club.
January 26.—A party from Southbury Road Boys' School.
February 5, 12, 19 and 26.—Contingents of Indian troops.
February 13.—A contingent of a Guards Brigade.
February 28—Members of the South London Botanical Institute, and a party of Belgians from the Putney War Refugees Committee.

In connection with these visits the dioramas of places "in the news" have been a source of much interest. Two of these dioramas, although not new additions to the Galleries, are figured in this issue. The following is a copy of the printed descriptive label

PLATE I



SYDNEY HARBOUR

Reproduced from a Diorama in the Australian Court Exhibition Galleries Imperial Institute

[Facing page

PLATE II

On the Irrawaddy

Reproduced from a Diorama in the Burma Court, Exhibition Galleries, Imperial Institute attached to the cabinet which contains the diorama of Sydney Harbour (Plate I):

Sydney Harbour

" Sydney, the capital of New South Wales and the largest city of Australia, is situated in one of the finest natural harbours in the world, a large scenic map of which, in oil colours, is exhibited on the opposite wall of this Court.

" This diorama shows part of the main harbour as viewed from Bradleys Head, a peninsula on the north side of the harbour. Garden Island and Farm Cove, a favourite anchorage for warships, are on the extreme left, and on the mainland beyond lies the chief industrial section of the city of Sydney.

" The *Strathnaver*, a P. & O. 21,000-ton turbo-electric liner, is leaving the harbour on her return voyage to England, while in the foreground yacht-racing is in progress.

" To the left of the liner can be seen the island of Fort Denison, which has long ceased to be used for defence purposes. Beyond the island fort in the distance is the colossal Sydney Harbour Bridge linking by means of a single span of 1,650 ft. the city on the south side of the harbour with its northern suburbs. It is the largest arch bridge in the world. The decking suspended from the arch of the bridge gives a clearance of 170 ft. for shipping and is 160 ft. wide, supporting four lines of electric railway, a roadway of 57 ft. width, and two footpaths each 10 ft. in width. The bridge was officially opened for traffic in 1932. Its total cost was nearly £10,000,000. It dominates the harbour, being visible by means of glasses from the deck of an approaching vessel long before the coastline comes into sight. The steel-work of the bridge reaches a height of 440 ft., the granite-faced pylons at each end of the main arch being 285 ft. high.

" Darling Harbour, where most of the wheat and wool, the great export products of Australia, are loaded and where nearly all the inter-State and coastal steamers have their berths, is situated beyond the bridge. Neutral Bay can be seen just to the right of the liner."

The other diorama (Plate II) shows a scene on the Irrawaddy River, and is of interest in view of the attention now being focussed on Burma. It was prepared by Mr. Herbert H. Rooke on behalf of the Irrawaddy Flotilla Company for display in the Burma Pavilion at the Empire Exhibition, Glasgow, and after the Exhibition closed it was presented to the Imperial Institute by the Company. The descriptive label for this diorama reads as follows:

Burma's Great Waterway—the Irrawaddy River

" This diorama shows one of the steamers of the Irrawaddy Flotilla Company at a typical calling place on the right bank of the

Irrawaddy River in Upper Burma. It is the low-water season, and the shelving bank of the river is exposed. Villagers are embarking with their produce, and passengers who have left the steamer can be seen on the shore where there is also a Burmese hut.

" In the distance can be seen another of the Company's vessels coming down stream, while drifting down with the current is a teak-log raft in charge of its crew. Flying over the hills in the distance to the right can be seen one of the Company's seaplanes, and dotting the landscape are a number of picturesque pagodas. The hills on the far side of the river are of sandstone with a curiously slanting formation, and bear stunted vegetation. The scene is in Burma's oil area, and an oil derrick can be discerned on the sky-line."

Through the courtesy of U Hla Phaw, the accredited London correspondent of *The Sun* newspaper, Rangoon, a set of photographs depicting scenes, peoples and places along the section of the "Burma Road " in Burma has been acquired and is displayed on a pilaster near the relief map of Burma.

A small map has also been prepared and displayed in conjunction with the relief map of Burma to show the rail and motor routes from Rangoon to Lashio, and the Burma Road from Lashio, the rail head, and from Bhamo, the head of the river navigation, to Kunming and thence to Chungking.

New Exhibits.—A collection of stamps of countries of the Colonial Empire has been recently received for exhibition in the Colonial Empire Court after having been displayed under the auspices of the former Colonial Empire Marketing Board at the World's Fair, New York, 1939-40.

The stamps number 268 and are current issues. They represent sixty-two different Dependencies and Protected States and show in their designs a great variety of colouring and subject matter. A number of them illustrate the economic industries and products of the particular country represented, and it is apparent that the designers of some of the stamps have found in the Imperial Institute Exhibition Galleries useful material which they have drawn upon for their designs, scenes in our illuminated dioramas being reproduced in some cases on the stamps.

The collection is displayed in eight frames, and the stamps are arranged in geographical groups, each group centring round a neatly-drawn map of the area in which the stamps are issued; and each stamp is linked by a red line to its own particular country on the map.

Stamps illustrating economic subjects are numerous in the West Indian groups. Jamaica has four picturing important export industries: the harvesting of sugar-cane with a sugar refinery in the distance, the harvesting of bananas, a citrus grove with a woman picking the fruits, and coconut palms in fruit. Two stamps of the Turks and Caicos Islands, a dependency of Jamaica, illustrate operations in the manufacture of salt; and one of the Cayman Islands, another dependency of this Colony, shows coconut palms with turtles on a sandy coast, the live green turtle and the tortoise-shell of the hawksbill turtle furnishing the principal export products. A Trinidad and Tobago stamp pictures the discovery, by Sir Walter Raleigh in 1595, of the Trinidad pitch or lake-asphalt, the material now in universal use for road surfacing; and a St. Lucia stamp shows the loading of bananas for export to the Canadian market. The staple export industry of Dominica is represented by a scene showing the picking of limes, and that of Montserrat by a view of cotton plantations with the cotton pickers at work.

The British Honduras stamps are especially rich in economic illustrations, showing the felling of mahogany trees, the transport of timber by rafting down a river, the harvesting of grape fruit, the tapping of a chicle tree for chewing-gum, a chicle-refining factory, and the cohune palm with its oil-yielding edible fruits. This Colony, to emphasise still further its economic side, has issued a stamp bearing on scrolls on either side of the King's head the names of eight of its principal products—chicle, mahogany, grape fruit, coconuts, bananas, cohune, sugar and rice.

Sugar, the most important export crop of British Guiana, is illustrated by a scene showing the sugar-cane fields and the canal transport in punts of the harvested cane to the factory. Other stamps of this Colony show the ploughing of a flooded rice field, the river transport of timber logs, the mining of alluvial gold, and a native method of fishing with bow and arrow. In the Falkland Islands stamps the important wool production of the Colony is represented by a flock of sheep, and the whaling industry by a whaling station and a trophy of whale's jaw-bones.

In the South Western Pacific Group the important phosphate deposits of the Gilbert and Ellice Islands are represented by a picture showing the loading of a vessel by means of the special cantilever jetty on Ocean Island. Other stamps of this Colony show the coconut palm and the pandanus tree, the latter providing in its leaves a staple domestic mat-making material. The Fiji stamps picture the Colony's important sugar industry and the native practice of fishing with a spear by torch-light. A good illustration of the leaves and fruit of the bread-fruit tree is given on a stamp of the Solomon Islands where the fruit forms a staple food.

The importance of rice as a staple food in British Malaya is represented by a sheaf of rice in ear on a stamp of the Kedah State, where the production is considerable. Two of the Ceylon stamps give admirable pictures of the tapping of a rubber tree and the plucking of tea, representing Ceylon's two most important export products. A Seychelles stamp shows the interesting coco-de-mer palm with its "double coconut" fruits, this palm being native only to this Colony; other stamps show the giant tortoise, and the local pirogue or fishing boat.

Amongst the African stamps that illustrate the products or economic activities of their respective countries are one of Sierra Leone showing the harvesting of rice; a Uganda, Kenya and Tanganyika stamp showing a distant view of a sisal fibre plantation; one of the Bechuanaland Protectorate picturing native cattle; and a Somaliland stamp showing the black-headed sheep of the Colony, a valuable source of mutton and of leather for suede gloves. A Northern Rhodesian stamp pictures big game in the form of elephant and giraffe.

The loan of photographs of mechanical excavators and dredgers used in the Nigerian tinfields has been obtained through the good offices of the London Tin Corporation, Ltd. Suitable enlargements for exhibition have been prepared from them, and these are shown with tin specimens and the diorama of hydraulicing for tin in the Nigerian section of the West African Court.

In the British Guiana Court the exhibits and photographs illustrating the rice, gold and diamond industries have been rearranged in story form and have thereby gained considerably in appearance and in popular appeal.

Copies of a vegetation map showing forest areas have been received from the Conservator of Forests, British Honduras, for exhibition with the timber specimens in the Court.

The re-touching of some of the older Indian dioramas which had become somewhat tarnished owing to lengthy exposure has been carried out by the artists originally responsible for their design and construction.

Photographs from the Collections have been loaned to the Press and to publishers of educational books dealing with Empire topics.

Central Film Library.—By the end of 1941 the Central Film Library had grown to be the largest library of documentary and educational films in Great Britain, and probably in the world, and January 1942 saw the Library still developing. By that month there were in the Library 11,000 copies of 720 different films. Twenty new films dealing with Australia, Canada, India and the United Kingdom had been added to the Empire section of the Library, and 55 new films had been added to the Ministry of Information section. Further films are being added to both sections and to the G.P.O. section every month. The number of organisations borrowing from the Library continues to increase, and by the end of January 1942 the figure had passed 6,000.

The range of films in the Library is now remarkable. It covers not only general educational films about the Empire countries and the United Kingdom, but also many films on the war effort in most of the Empire countries and in this country. It also includes films about many of the allied countries and within a few months a considerable number of educational films about the U.S.A. will have been added, which will be invaluable to schools. As well as films giving general information, the Library now includes a number of detailed instructional films on farming, gardening, health and civil defence, all of them added since the war, but most of them having educational validity at any time. These developments in the range of films have meant that the Library has been able to serve an increasingly large number of interests, and there are few organisations, whether they are schools, technical institutes, A.T.C. Squadrons, Young Farmers' Clubs or allotment societies which cannot and do not borrow from the Library films suitable for their purposes. In the same way any local government authority or community wishing to arrange meetings or lectures on important war-time subjects is able to borrow films which will assist in informing and instructing audiences. During November and December 1941 and January 1942 the Library despatched 21,883 films to borrowers. This is more than 7,000 films a month as against an average month's despatch during the previous twelve months of 5,000.

Empire Lantern Slide Library.—The circulation of lantern slides of the Empire to schools, Women's Institutes, societies and army educational authorities during the period November, December and January totalled 19,060. The details are shown in the following table:

	November.	December.	January.
Australia	1,140	360	360
Canada	1,260	660	960
New Zealand	360	240	360
South Africa	200	100	300
India	1,140	600	900
Burma	240	100	300
Territories of the Colonial Empire	2,100	2,040	2,640
Products of the Colonial Empire	60	120	180
General Tours of the Empire	660	—	720
History of the Empire	240	600	120
	7,400	4,820	6,840

A new picture talk on Nyasaland has been printed. It was written by Dr. I. M. W. A. Black, of the Nyasaland Department of Agriculture. The talk begins with a general survey of the position of the country in the centre of Africa and its chief physical features—the Zambesi River; the Rift Valley; the Zomba Plateau and Lake Nyasa. The importance to Nyasaland of the Zambesi Bridge and the significance of communications generally is explained by showing that this inland country would be unable to export its products unless the roads and railways had been built and were adequately maintained. This is followed by a description of the main crops—cotton, tea, cereals and tobacco; the native methods of cultivation and the native way of living. The talk concludes with a brief reference to the contributions to the welfare of the country made by the settlers, the Livingstone Mission and the various Government Departments in a common effort to raise the standard of living and make the country increasingly productive.

Imperial Institute Stories of Empire Products.—Further progress has been made with the second series of six posters and descriptive leaflets dealing with the production and uses of some typical colonial products. In the last issue of this BULLETIN, 1941, 39, 437, a brief description was given of No. VII, " Malayan Rubber—From Trees to Tyres, Toys and Telephones," and it was then intimated that No. VIII was in active preparation. This has now been completed and issued. It bears the title " East African Sisal—From Leaf to Sheaf " and describes the origin and history of this comparatively new fibre; then proceeds to trace the story of its cultivation, extraction and preparation, and concludes with a descriptive tabulation of its chief uses as a binder twine in the harvest field; as a parcelling twine for newspapers and other bulky packages; as material for ropes and cordage; for the manufacture of mats, carpets and hats; for stuffing in upholstery; for reinforcement in paper; and for coarse textiles. No. IX, " Ceylon Tea—From Leaf-cell to Tea Cup," has also been completed. This story tells how tea, our most popular beverage, came to us first as a novelty from China and how when the drink had become popular, Empire industries were started which now supply the greater part of our tea requirements. Sketches and descriptive notes illustrate the tea plant, the plucking of the leaves and the ingenious processes, first evolved by the Chinese, by which the stimulating juices in the leaf cells are liberated and dried in the rolled leaf to be ultimately recovered and enjoyed in the tea cup.

Story No. X, which treats of British Guiana Rice, is in active preparation.

Empire Lectures to Schools.—During November the number of lectures given under the Imperial Institute scheme was 89, and audiences for that month reached 13,300. In December and January the demand for lectures fell owing to school holidays, the figures for these months being 55 and 44 respectively; bookings have, however, been steady since the schools re-opened. In some areas, where there was a scarcity of lecturers dealing with the subjects desired, Empire lecture tours have been arranged from school to school, and these have proved very popular. The number of lecturers on the Panel is now nearly one hundred.

Colonial Visitors.—The following is a list of officers on leave from the Colonial Empire who have visited the Institute during the period November 1941—January 1942.

NOVEMBER 1941

Dr. D. A. **BRYN-DAVIES**, Field Geologist, British Guiana.
B. E. **FRAYLING**, Chief Inspector of Mines, Nigeria.
L. H. **SAUNDERS**, Agricultural Superintendent, The Gambia.

DECEMBER 1941

I. G. **JONES**, Colonial Labour Adviser, Gold Coast.
J. **STIRLING**, Colonial Labour Adviser, Trinidad.

JANUARY 1942

R. M. **HARLEY**, Assistant Conservator of Forests, Gold Coast.
J. E. H. **WHITE**, Education Officer, Nigeria.

All Dominion and Colonial Officers, as well as private residents overseas, who may be visiting London, are cordially invited to come to the Institute to see the Exhibition Galleries and to discuss scientific and technical problems in which they may be interested.

BULLETIN
OF THE IMPERIAL INSTITUTE

VOL. XL. NO. 2. APRIL-JUNE, 1942

PLANT AND ANIMAL PRODUCTS

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Indian and Colonial Governments

PO-YOK FRUITS FROM SIERRA LEONE

At the present time considerable attention is being devoted to oils which might be suitable for use in place of tung oil. Among the most promising of these is Oiticica oil obtained from the kernels of *Licania rigida*, a tree belonging to the natural order Rosaceæ and occurring in Brazil. Another oil possessing similar properties is that derived from the kernels of the Po-yok tree (*Afrolicania elæosperma*) of tropical West Africa, which is very closely related to Oiticica.

Reports on the examination of po-yok oil at the Imperial Institute were published in this Bulletin, 1918, **16**, 38; 1935, **33**, 271. Particulars of the distribution and character of the tree, the nature of the fruits and local uses of the oil were given in the second of these reports. In March 1940 and January 1941 further samples of Po-yok fruits were received at the Imperial Institute from the Director of Agriculture, Sierra Leone and the results of their examination, including paint and varnish trials with the oil, are given below. Rheineck (*Paint, Oil Chem. Rev.*, 1937, **99**, No. 9, 7-8) and Steger and van Loon (*Rec. Trav. Chim.*, 1938, **57**, 620) have also investigated po-yok oil. They regard it as intermediate in properties between oiticica oil and tung oil.

The samples recently examined at the Imperial Institute were as follows:

Sample No. 1.—Received in May 1940. This consisted of whole fruits of normal appearance. The shell was pale to dark brown in colour, from 1¼ to 2 in. long, 1 to 1½ in. in diameter, and up to about 1/13 in. thick. The kernel varied from golden to purplish brown in colour, and was hollow, the flesh being about ¼ in. thick.

Sample No. 2.—Received in April 1941. These fruits were similar in appearance to those of the first sample, but on the whole of smaller size. The fruits varied in length from 1¼ to 1¾ in., and from ¾ to 1½ in. in diameter.

Examination of Fruits and Oil.—The fruits and the oils prepared from the kernels by extraction with light petroleum were examined with the results shown in the following table, which are shown in comparison with the analytical figures obtained at the Imperial Institute for previous samples of po-yok. These previous samples consisted of six samples of fruits from which oil was prepared at the Imperial Institute, and one sample of oil prepared in Sierra Leone:

		Present Samples.		Range of Previous Samples.
		No. 1.	No. 2.	
Average weight of a fruit .	*grams*	15·8	11·2	7·3 to 11·8
Average weight of a kernel	,,	9·4	6·6	4·6 to 7·2
Shell in fruits	*per cent.*	40·5	42·3	31·4 to 44·0
Kernel in fruits . . .	,,	59·5	57·7	56·0 to 68·6
Moisture in kernels . .	,,	5·1	5·7	5·9 to 9·0
Oil in kernels as received .	,,	51·2	54·8	41·7 to 58·3
Oil in kernels, moisture-free	,,	54·0	58·1	45·8 to 63·8
Oil in fruits as received .	,,	30·5	31·6	32·6 to 39·4
Constants of the Oil—				
Specific gravity at 15·5/15·5° C. . .		0·9619	0·9593	0·9535 to 0·9690
Refractive index at 20° C. . . .		1·5160	1·5175	1·5020 to 1·5110
Acid value		2·9	7·8	0·4 to 19·3
Saponification value		189·9	191·5	188·0 to 192·3
Iodine value (Wijs, 1 hr.) .	*per cent.*	148·2	150·1	139·9 to 157·1*
Unsaponifiable matter .	,,	0·8	0·7	0·3 to 1·0
Heat test (Paint Research Station) 290° C. Time in mins. . . .		22½	18½	See below
Extractive (unpolymerisable)	*per cent.*	52·5	41·9	—
Colour—tintometer reading, 1 in. cell—				
Red		1·7	3·7	—
Yellow		16	30	—

* *Wijs 3 hours or Hubl 17 hours.*

Heat Test (at 300°c.) on previous samples:—In four samples of oil no gelation took place on heating for 30 minutes. In one sample jelly formed after 16 minutes, in another after 20 minutes. In the other sample no gelation occurred after more than 10 minutes heating at 280°c.

Paint and Varnish Trials.—Samples of the two oils were submitted to the Research Association of British Paint, Colour and Varnish Manufacturers, who carried out technical trials and reported as follows.

" *Examination of Po-Yok Oil*

I. *Samples.*

Sample No. 1 was rather cloudy, whilst No. 2 was almost clear, at ordinary temperatures. Both oils became star-bright on gentle warming. The oils had a smell similar to that of tung oil and at ordinary temperatures were more viscous than raw linseed or tung oils.

Sample No. 2, being the clearer of the two, was examined for varnish-making properties as far as was possible with the small quantity available.

II. *Varnish and Paint-making Experiments.*

(*a*) *Drying Properties.*—Under laboratory conditions, without drier, a film of the oil on glass became skin-dry in 24 hours, and did not dry right through until after 10 days. Even then, the film, although coherent, was cloudy and inelastic.

Films containing approximately 0·1 per cent. cobalt (as naphthenate solution) dried through in 24 hours, but 'webbed' in the manner associated with raw tung oil films.

(*b*) *Bodying Properties.*—The product of heating the raw oil at 220-240° C. for 30 mins. was a pale, star-bright, stand oil of about 8 poises viscosity, i.e. the thickening was rather less than would be obtained with raw tung oil under similar conditions, but considerably greater than that of raw linseed oil.

(*c*) *Varnish-making.*—The oil was found to be compatible with both natural resins (e.g. congo copal and rosin) and synthetic resins (e.g. phenolic resins). Varnishes of 2 : 1 oil length were made using rosin, a pure phenolic resin (Bakelite XRB 254) and a modified phenolic resin (Albertol 111L). They were pale in colour, and before thinning were slightly less viscous than similar products obtained with tung oil under similar conditions.

With equal quantities of cobalt driers the drying time was 10-25 per cent. longer using po-yok oil than with tung oil, but was much shorter than that of corresponding products using linseed oil.

The resistance of films of the po-yok oil pure phenolic resin varnish to immersion in boiling water for 1 hour was good, and of the same order as that of the tung oil varnish. Immersion in 10 per cent. caustic potash solution (cold) for 24 hours caused slight clouding and softening of the po-yok varnish films. In this test the po-yok oil product, whilst inferior to the corresponding tung oil varnish, was superior to a corresponding linseed oil varnish.

The modified phenolic resin po-yok oil varnish dried hard and tack-free in 3-4 hours with good gloss. The film was resistant to immersion in cold water for 24 hours and in boiling water for 30 mins.

(*d*) *Paint-making.*—Heat-bodied po-yok oil prepared at 220-240° C. as described above, with 0·1 per cent. cobalt, was pigmented with titanium dioxide (1 : 1 pigment : oil ratio) and thinned with xylol. The paint so prepared when brushed out on metal panels dried in 8 hours to a flexible matte film.

III. *Conclusions.*

The indications are, from the limited number of experiments that it has been possible to carry out with the small amount of material available, that po-yok oil has valuable varnish and paint-making properties of the same type as, but not the equal of, those of tung oil, and generally superior to those of linseed oil."

Remarks

The constants of the oils prepared from the two samples of fruits fall within the range of figures recorded for previous samples examined at the Imperial Institute, with the exception of the refractive index which is very slightly higher.

With regard to the iodine value, the present samples have values which fall roughly midway in the range of previous figures.

Both the present samples formed gels in the heat test; in this respect two previous samples showed gelation while five samples did not jellify under the test.

The property of forming a gel on heating shows the present samples to be more satisfactory than those previous samples which did not possess that property, but in comparison with tung oil, for which a result of about 9 minutes in the heat test is usually obtained, it is seen that both the present samples are inferior in respect of the desired gelling property. The second sample is somewhat better than the first sample, however, in this respect. The gels obtained from the present oils were distinctly sticky and could not be cut with a knife as in the case of gels prepared from tung oil. Further, the amount of oil which remains unpolymerised in the heat test, i.e. extractive, is high, 41·9 and 52·5 per cent. as compared with the usual figure of about 20 per cent. for tung oil.

The varnish and paint-making trials carried out showed the present samples of oil to possess satisfactory properties for these purposes, being generally superior to linseed oil but not equal to tung oil.

In the previous report in this BULLETIN (1935, **33**, 273) it was suggested that the number of trees existing in Sierra Leone was very limited. Since then, the Imperial Institute is informed by the Director of Agriculture, a further survey has been made of another part of the country which shows that the trees are more numerous than was originally supposed. It is now thought that possibly 50 to 100 tons of kernels could be shipped annually. This relatively small quantity would render the material of little interest for export in normal times, but under the present war conditions it is worth consideration. The fact that the residual meal after extracting the oil is not suitable for use as a feeding stuff is a drawback to importing the kernels into the United Kingdom.

It was pointed out to the authorities in Sierra Leone that it is important to note with reference to the collection of fruits for the export of kernels or oil that the oil to be acceptable for paint and varnish manufacture must possess gelling properties similar to those of the samples now under report. This was not the case with many of the samples of po-yok previously received at the Imperial Institute from Sierra Leone; hence care must be taken that the material is collected from the same botanical source and under the same general conditions as the present samples.

PUTREFACTION IN CATTLE HIDES

RESULTS OF DELAYED DRYING TRIALS IN NIGERIA AND KENYA

To obtain the best results cattle hides should be dried as soon as possible after flaying, otherwise putrefactive damage is liable to occur. In order to determine the maximum period which can safely be allowed to elapse between the operation of flaying and the suspension of the hide for drying a series of preliminary trials was carried out by the Director of Veterinary Services, Nigeria, early in 1939. Specimens of hides produced in the course of the experiments were submitted to the Imperial Institute for examination, and it was found that in this particular case delay in drying had had no appreciable effect on the quality of the hide. The Imperial Institute Consultative Committee on Hides and Skins recommended that further and more comprehensive trials should be carried out in Nigeria and that it was desirable that comparative trials should also be made in Kenya in two localities, one having dry and the other humid conditions. The lines on which the experiments in Kenya should be conducted were drawn up by the Committee and in due course samples of hides from both countries were sent to the Imperial Institute. The reports on the hides from the second series of trials in Nigeria and from the Kenya trials are given separately below.

It will be seen that the Kenya experiments showed clearly that both in the hides from the dry and the humid localities putrefactive damage increased with the delay period, whereas in the case of the Nigeria trials a delay period of up to 32 hours between flaying and suspension for drying did not appear to be more productive of putrefactive damage than drying the hide immediately after flaying.

The reason for these different results is not evident. It may be connected with the climatic conditions obtaining at Kano, where the Nigerian experiments were carried out, but it would not seem advisable to encourage delay as a general practice in that region until the matter is more clearly understood.

I. CATTLE HIDES FROM DELAYED DRYING TRIALS IN NIGERIA

Details of the Drying Trials

The trials were carried out at Kano with hides obtained from the City Slaughter Slab on four different days in December 1939. Two methods were followed.

I. *Arsenication before Delay Period.*

After flaying, the green hides were arsenicated by immersion for 30 minutes. Each hide was then bundled up, by doubling it in from the sides, the hair surface being the outer one. The bundles were submitted to delay periods in the sun, at the end of which the hides were suspended on frames and dried in the sun. There were four different delay periods, each employing 10 hides.

Trial	W 8.	Delay period,	8	hours.
„	W 16.	„ „	16	„
„	W 24.	„ „	24	„
„	W 32.	„ „	32	„

II. *Arsenication after Delay Period and Drying.*

The green hides were bundled up as in Method I and submitted to delay periods in the sun. The hides were then suspended on frames and dried in the sun. The dried hides after removal from the frames were arsenicated by dipping for 1 minute in an arsenical bath, and exposed to the sun to dry, but not framed, as the second drying was rapid. Each trial employed 10 hides.

Trial	D 16.	Delay period,	16	hours.
„	D 24.	„ „	24	„
„	D 32.	„ „	32	„

Delay Period.—The time stated for the delay period starts from the time the hide was bundled up. The actual time between flaying and the commencement of drying is from 1½ to 3 hours longer than the specified delay period.

Meteorological Record for December 1939 *at Kano*

Temperature :	Shade—	Mean Minimum	52° F.
		Mean Maximum	93° F.
		Mean Daily	72·7° F.
	Sun—	Maximum	142° F.
Relative Humidity—	9 a.m.		45 per cent.
	3 p.m.		16·6 per cent.
Rainfall			nil

Inspection of the Hides

The dry hides on arrival at the Imperial Institute were inspected by Dr. Dorothy Jordan Lloyd, Chairman, and Dr. J. R. Furlong, Secretary, of the Imperial Institute Consultative Committee on Hides and Skins.

The bales were opened on May 3, 1940. Each contained 10 hides, which were folded once down the middle of the back, hair side inwards. The hides one by one were inspected, with the following results.

I. *Arsenication before Delay Period.*

(1) *Trial W*8.—Delay period, 8 hours.
2 hides showed hair slip and had a putrid smell.
8 hides showed only very small patches of slip, and had no noticeable smell.

(2) *Trial W*16.—Delay period, 16 hours.
All hides showed small patches of hair slip and had a slight smell.
3 showed blister.

(3) *Trial W*24.—Delay period, 24 hours.
8 hides showed small patches of hair slip; 2 without..
1 hide showed blister.
Fairly strong smell was general.

(4) *Trial W*32.—Delay period, 32 hours.
4 hides showed very small patches of hair slip; 4 without.
Not much smell evident.

II. *Arsenication after Delay Period and Drying.*

(5) *Trial D*16.—Delay period, 16 hours.
8 hides showed small patches of hair slip, and had a little smell.
2 hides with a large hole each, suggestive of gnawing by rats.

(6) *Trial D*24.—Delay period, 24 hours.
All hides showed small patches of hair slip, and had a moderately strong smell.

(7) *Trial D*32.—Delay period, 32 hours.
All showed small patches of hair slip, and had a pronounced putrid smell.

General Remarks.—The hides from all trials were generally clean, except for occasional small portions of fat, and were nicely flayed. The hides were practically free from grubs; only very few were seen, and no damage due to grubs was observed.

The hides from Trial D32 had more smell than any of the others. In other respects, particularly as regards indications of putrefactive damage, the lots were not noticeably different.

Weights of Bales

Each bale (10 hides) was weighed at the Imperial Institute on May 3. Weight of binding rope was included, and was roughly about 1 lb. for each bale.

(1)	W8	1 cwt. 74 lb.
(2)	W16	1 cwt. 63 lb.
(3)	W24	1 cwt. 50 lb.
(4)	W32	1 cwt. 47 lb
(5)	D16	1 cwt. 54 lb.
(6)	D24	1 cwt. 32 lb
(7)	D32	1 cwt. 24 lb

Tanning Trials

The hides were transferred to the Penketh Tanning Co., who are members of the Imperial Institute Consultative Committee on Hides and Skins, for tanning trials to ascertain the putrefactive damage, if any, resulting from the delay in commencing drying. The firm reported as follows:

(*a*) *Condition of Hides on Arrival.*

We could see no difference between the lots W8-W32 and D16-D32. All appeared very bright clean cure, and looked very sound.

(*b*) *Lime Yard Report in Pelt State* (i.e. on the hides after liming, dehairing and fleshing).

I. *Arsenication before Delay Period.*

Trial W8.—Gain on Imperial Institute weight of 1 cwt. 74 lb. = 274·6 per cent. No actual putrefaction, but 80 per cent. were spotted on the grain which looked like the very first stages of putrefaction. No actual damage done.

Trial W16.—Gain on Imperial Institute weight of 1 cwt. 63 lb. = 280 per cent. All perfectly sound.

Trial W24.—Gain on Imperial Institute weight of 1 cwt. 50 lb. = 274 per cent. Could see no visible signs of putrefaction with the exception of one hide which had a piece of about 1 in. in diameter putrefied—otherwise excellently sound pelt.

Trial W32.—Gain on Imperial Institute weight of 1 cwt. 47 lb. = 288·1 per cent. All perfectly sound, no signs of spotted grain.

II. *Arsenication after Delay Period and Drying.*

*Trial D*16.—Gain on Imperial Institute weight of 1 cwt. 54 lb. = 269·8 per cent. While there was no definite rottenness present, practically all showed signs of grain putrefaction in its early stages, " spotted grain "—otherwise sound.

*Trial D*24.—Gain on Imperial Institute weight of 1 cwt. 32 lb. = 294·4 per cent. Very slight signs of putrefaction having started by spotted grain and white spots—otherwise sound.

*Trial D*32.—Gain on Imperial Institute weight of 1 cwt. 24 lb. = 288·2 per cent. 70 per cent. were spotted on grain, being first stages of putrefaction, otherwise sound.

Summary.—Actually taking both lots into account, there was very little difference. D16/32, if anything, were more spotted on the grain than the W8/32, but this difference was so slight that practically speaking there was nothing to choose between either lot, as the spotted grain mentioned above is only the first stages of putrefaction, and is only just visible. This is not what you would call a serious damage, although, of course, it must have weakened the fibre to some small degree.

(*c*) *Report on the Finished Leather.*

*Trial W*8.—On the whole very sound, one or two with rather rough grain but no putrefaction.

*Trial W*16.—No signs of putrefaction, perfectly sound.

*Trial W*24.—30 per cent. very slight tender grain, hardly noticeable, otherwise very sound.

*Trial W*32.—Slight signs of surface putrefaction having commenced, noticeable by the lighter colour of the grain in patches, but remarkably sound on the whole seeing that they have been left for 32 hours.

*Trial D*16.—25 per cent. contained patches of tender grain, only very slight, showing that putrefaction had started, otherwise very sound.

*Trial D*24.—20 per cent. very slight grain damage, tender grain, otherwise very sound.

*Trial D*32.—25 per cent. tender grain, only very slight, the remainder very sound, surprisingly so.

Examination of the Finished Leather

Samples of the finished leather were examined by the British Leather Manufacturers' Research Association. Two samples from the finished sole bends from each trial were subjected to microscopical investigation and physical tests, including resistance to abrasion, with the following results.

NOTES ON TERMS AND STANDARDS

Micro-assessment—
8 = maximum
> 5·6 = Very good
5·6—5·0 = Good
4·9—4·3 = Fair
< 4·3 = Poor.

Loss on dry abrasion (mm./min.)
< 0·35 = Good
0·35—0·40 = Fair
> 0·40 = Poor.

Q15 (mins.)
Q24 (hours) = Percentage increase in weight after soaking for 15 minutes and 24 hours respectively.

Free Water Percentage expressed on original sample. It represents the water which a leather will hold at saturation.

(*i*) *Results of Micro-Assessment and Abrasion Tests on Finished Sole Bends*

(*a*) *Arsenication before delay period*

No. of sample.	No. of hours delay.	Photo-micrograph No.	Micro-assessment.	Average loss (whole thickness) on dry abrasion (mm./min.).	Averages—different delay periods.	
					Micro-assess.	Abrasion results.
W8 1 .	8	G318	4·7	0·37	4·9	0·39
W8.2 .	8	G319	5·1	0·40		
W16.1 .	16	G320	4·2	0·36	4·2	0·36
W16.2 .	16	G321	4·2	0·36		
W24.1 .	24	G322	4·1	0·37	4·9	0·35
W24.2 .	24	G323	5·7	0·33		
W32.1 .	32	G324	4·5	0·29	4·3	0·27
W32.2 .	32	G325	4·1	0·24		
Average—W series :			4·6	0·34		
		(*b*) *Arsenication after delay period and drying*				
D16.1 .	16	G312	5·9	0·24	6·1	0·28
D16.2 .	16	G313	6·3	0·31		
D24.1 .	24	G314	6·2	0·23	6·3	0·29
D24.2 .	24	G315	6·4	0·35		
D32.1 .	32	G316	6·7	0·28	5·7	0·34
D32.2 .	32	G317	4·6	0·39		
Average—D series :			6·0	0·30		

Both the micro-assessments and the results of the abrasion tests show the "D" series (arsenication after delay and drying) to be better as a whole than the "W" series (arsenication before delay period). No consistent differences, according to the period of delay, are seen between the trials in either series.

(ii) *Results of Water Absorption Tests on Finished Sold Bends*
(*a*) *Arsenication before delay period*

Sample.	Density		Q15 (min.).	Q24 (hours).	Free Water.	Percentage Loss on soaking.	*p*H Water Extract
	Before soaking.	After soaking.					
W8.1 .	1·090	0·891	14·8	18·0	34·8	14·8	4·72
W8.2 .	1·072	0·934	14·0	17·2	32·7	15·5	4·82
W16.1 .	1·082	0·908	14·5	21·1	37·6	16·5	4·81
W16.2 .	1·102	0·931	14·3	21·7	36·0	14·3	4·79
W24.1 .	1·147	0·947	14·0	18·0	33·6	15·6	4·76
W24.2 .	1·114	0·974	10·4	20·4	31·9	11·5	4·86
W32.1 .	1·124	0·962	14·4	18·1	33·0	14·9	4·90
W32.2 .	1·110	0·932	11·5	18·8	33·6	14·8	4·80
Average W series :	1·105	0·935	13·5	19·2	34·2	14·8	4·81
	(*b*) *Arsenication after delay period*						
D16.1 .	1·115	0·980	10·2	17·2	32·0	14·8	4·75
D16.2 .	1·025	0·907	17·4	20·2	34·5	14·3	4·96
D24.1 .	1·055	0·951	11·3	20·1	30·6	10·5	4·94
D24.2 .	1·113	0·961	15·4	20·2	34·5	14·3	4·91
D32·1 .	1·048	0·937	16·8	20·6	33·6	13·0	4·91
D32·2 .	1·127	0·935	12·3	18·7	34·3	15·6	4·92
Average D series :	1·081	0·945	13·9	19·5	33·3	13·8	4·90

There are no significant differences shown in this Table between the two series, " W " and " D," or between the individual trials in the series. The figures for both series are within the limits usually found in sole leathers of reasonably good quality.

Conclusions

Delay Period and Putrefaction.

Inspection of the raw hides on arrival in London, and again on arrival at the tannery, showed no correlation between the amount of putrefactive damage and the length of the delay period before drying the hides. It is to be noted, however, that hides from the 24- and 32-hour delay periods had a stronger putrid smell than the hides from the 8- and 16-hour delay periods, with the exception of Trial W32.

The pelts in the limed state showed slight putrefaction on the grain, but the amount present was not related to the length of the delay period.

Inspection of the leather produced, in its finished state as sole bends, showed that in one series, " D " trials (arsenication after delay period and drying), there was no connection between the amount of grain damage, which was very slight, and the extent of the delay period. In the other series, " W " trials (arsenication before delay period) very slight putrefactive damage was present in the leather from the 24- and 32-hour delay periods, but was not seen on the leather from the 8- and 16-hour delay periods.

The results obtained from the microscopical and physical examination of the finished leather showed no consistent differences according to the period of delay.

Arsenication before and after Delay Period.

In comparing the two series, " W " (arsenication before delay period) and " D " (arsenicated after delay period and drying), as whole series, no difference between the hides in the raw state in respect of putrefaction was observed. In the limed pelt condition " D " series was very slightly more spotted by putrefaction than the " W " series, and as finished leather there was the same tendency to more damage in the " D " series.

The examination of the finished leather, however, revealed a small but well-defined difference between the two series. Both the micro-assessments and the results of the abrasion tests showed the leather from the " D " Series to be superior to that of the " W " series. This result is not in accordance with the observed putrefactive damage, which as stated above was slightly more noticeable in the " D " series. The cause of the lower quality of the leather in the " W " series is not clear. The differences in procedure between the two series do not appear to supply an explanation.

Summary.

To sum up, these trials have not shown that a delay period of up to 32 hours between flaying and suspension for drying is more productive of putrefactive damage than drying the hide immediately after flaying. Slight indications against the longest periods were noticeable but the differences were not sufficiently pronounced to permit of definite conclusions.

The trials provided no definite evidence that arsenication before delay, on the scale employed in these trials, has a protective effect against putrefaction, since differences in this respect between series " W " and " D " were slight and inconclusive.

II. Cattle Hides from Delayed Drying Trials in Kenya

Details of the Drying Trials

The trials were conducted according to the scheme drawn up by the Imperial Institute at (1) Isiolo, Northern Frontier District (October 1939), as representing normally dry climatic conditions and (2) Mombasa, Coast Province (January-February 1940), as typical of normally humid conditions. The procedure at both places was the same, and was as follows :

Forty hides were employed in each set of trials. They were cut into halves along the middle of the back from neck to tail, while in the green condition immediately after flaying. One half of each hide was taken as a control half and suspended within two hours of flaying on a frame in the sun to dry. The other half of the hide formed the test half, and was folded double, flesh side inwards, and allowed to lie flat on the ground in the sun for a given period. At the end of the period the test half was suspended on a frame in the sun to dry. At Mombasa the frames were placed under cover when rain fell.

The delay periods were 8, 16, 24 and 32 hours, and for each of these four periods a batch of 10 hides was employed.

The control halves were marked with the letter "C," and the test halves with "T," and numbered.

All the control and test halves from the Isiolo trials were packed together in one bale, and all those from the Mombasa trials were in one bale.

Weights of Bales: Hide Marks

I. *Isiolo Trials.*—1 bale of 80 half hides. Weight, 4 cwt. 3 qr. 6 lb.

II. *Mombasa Trials.*—1 bale of 80 half hides. Weight, 5 cwt. 17 lb.

I. Isiolo

Trial.	Delay Period in hours.	Hide marks.
1st	8	C and T; 1 to 4, 17 to 20, 33, 34.
2nd	16	C and T; 5 to 8, 21 to 24, 35, 36.
3rd	24	C and T; 9 to 12, 25 to 28, 37, 38
4th	32	C and T; 13 to 16, 29 to 32, 39, 40.

II. Mombasa

Trial.	Delay Period in hours.	Hide marks.
1st	8	C and T; 1 to 10.
2nd	16	C and T; 11 to 20.
3rd	24	C and T, 21 to 30.
4th	32	C and T; 31 to 40.

Meteorological Conditions during trials

	Isiolo. October 1939.	Mombasa January-February 1940.
Normal conditions	Dry	Humid
Temperature: Shade—Minimum	61° F	81° F
Maximum	93° F.	92° F.
Relative Humidity—Minimum	13 per cent	60 per cent
Maximum	98 per cent.	100 per cent
Rainfall	Nil	Rain on several days.

Tanning Trials

The hides were transferred to the Penketh Tanning Co., who are members of the Imperial Institute Consultative Committee on Hides and Skins, for tanning trials to ascertain the putrefactive damage, if any, resulting from the delay before commencing drying. The firm reported as follows:

I. *Hides from Isiolo Trials.*

(*a*) *Condition of Hides on Arrival.*

Very little difference could be seen, apart from worm damage, which was present in all trials, but 90 per cent. of the hides damaged were the delay hides. The control hides in most cases had not been touched, although packed together with the delay hides in one bale.

(*b*) *Lime Yard Report* (i.e. on the pelts after liming, de-hairing and fleshing).

With reference only to putrefactive damage.

1st Trial. Daily Period, 8 hours

Hide Mark.	Control Hides "C."	Delay Hides "T."
1	Perfectly sound	Perfectly sound
2	,, ,,	,, ,,
3	,, ,,	Slight putrefaction on belly
4	,, ,,	Badly putrefied in three places
		Small white patches, probably first stages of putrefaction
18	,,	Slight putrefaction in two places
19	,,	Perfectly sound
20	,,	
33	,,	
34	,,	
	Percentage gain in weight from dry weight to limed pelt weight 175·0 per cent.	Percentage gain in weight from dry weight to limed pelt weight 189·5 per cent.

2nd Trial. Delay Period, 16 hours

Hide Mark.	Control Hides "C."	Delay Hides "T."
5	Perfectly sound	Badly putrefied on the shoulder, flesh side
6	,, ,,	Rotten completely
7	,, ,,	Slightly putrefied on the flesh
8	,, ,,	Very badly putrefied on the flesh
21	,, ,,	Perfectly sound
22	,, ,,	White spots as though putrefaction had just started
23	,, ,,	Perfectly sound
24	,, ,,	Very slight putrefaction on the grain side
35	,, ,,	Slight putrefaction on the grain
36	,, ,,	Perfectly sound
	Percentage gain in weight from dry weight to pelt weight 163·0 per cent.	Percentage gain in weight from dry weight to pelt weight 168·0 per cent.

3rd Trial. Delay Period, 24 hours

Hide Mark.	Control Hides "C."	Delay Hides "T."
9	Perfectly sound	Slight putrefaction on belly
10	,, ,,	Perfectly sound
11	,, ,,	Slight putrefaction on grain
12	,, ,,	Slight putrefaction in many places all over grain
25	,, ,,	Slight putrefaction on grain
26	,, ,,	Badly putrefied all over on grain side
27	,, ,,	Slightly putrefied in many places all over grain
28	,, ,,	Very slight putrefaction on the grain
37	,, ,,	Perfectly sound
38	,, ,,	Badly putrefied on grain side all over in small patches
	Percentage gain in weight from dry weight to pelt weight 170·0 per cent.	Percentage gain in weight from dry weight to pelt weight 175·7 per cent.

4th Trial. Delay Period, 32 *hours*

Hide Mark.	Control Hides "C."	Delay Hides "T."
13	Perfectly sound	Perfectly sound
14	,, ,,	Two or three patches on the flesh side putrefied, also white spots
15	,, ,,	Slight signs of putrefaction on grain side all over
16	,, ,,	Badly putrefied on flesh side of belly, also grain
29	,, ,,	Badly putrefied all over grain side and flesh
30	,, ,,	Badly putrefied on grain side all over
31	,, ,,	Slight putrefaction all over grain
32	,, ,,	Slight putrefaction all over grain
39	,, ,,	Slight putrefaction all over grain
40	,, ,,	Slight putrefaction on flesh side
	Percentage gain in weight from dry weight to pelt weight 169·6 per cent.	Percentage gain in weight from dry weight to pelt weight 172·0 per cent.

(*c*) *Report on the Finished Leather.*

With reference only to putrefactive damage.

1st Trial. Delay Period, 8 *hours*

1	Perfectly sound	Perfectly sound
2	,, ,,	,, ,,
3	,, ,,	,, ,,
4	,, ,,	Very badly blistered in 3 or 4 places
17	,, ,,	Very slight tender grain
18	,, ,,	Badly blistered on flesh side
19	Small patches of tender grain	Putrefied on flesh side, and tender grain
20	Perfectly sound	Slight tender grain
33	,, ,,	Perfectly sound
34	,, ,,	One small patch of putrefaction on britch.

2nd Trial. Delay Period, 16 *hours*

5	Perfectly sound	Perfectly sound
6	,, ,,	(Missing)
7	,, ,,	Perfectly sound
8	,, ,,	Badly blistered
21	,, ,,	Slight putrefaction all over
22	,, ,,	Small spots of tender grain
23	,, ,,	Small spots of putrefied grain
24	,, ,,	Putrefied grain in one or two places
35	,, ,,	Small spots of putrefied grain
36	,, ,,	Perfectly sound.

3rd Trial. Delay Period, 24 *hours*

9	Perfectly sound	Small spots of tender grain
10	Slight tender grain	Very slight tender grain
11	Perfectly sound	Small spots of tender grain
12	,, ,,	Very badly putrefied all over
25	,, ,,	Badly putrefied grain
26	,, ,,	Very badly putrefied all over
27	Very slight tender grain	Very badly blistered grain
28	Perfectly sound	One or two small patches of tender grain
37	,, ,,	Two small spots of tender grain
38	,, ,,	Badly putrefied grain.

4th Trial. Delay Period, 32 *hours*

Hide Mark.	Control Hides "C."	Delay Hides "T."
13	Perfectly sound	Perfectly sound
14	Very small patch tender grain down back bone	One very bad blister on flesh side absolutely rotten
15	One small spot of tender grain	One or two spots of tender grain, otherwise good
16	Perfectly sound	Badly blistered on flesh side, also tender grain
29	,, ,,	Very badly blistered all over
30	,, ,,	Badly putrefied grain
31	,, ,,	Badly putrefied grain, also one or two holes
32	,, ,,	Badly putrefied grain
39	Very slight tender grain in small patches	Putrefied grain in many patches
40	Perfectly sound	Bad spots of tender grain.

II. *Hides from Mombasa Trials.*

(*a*) *Condition of Hides on Arrival.*

1st Trial.—No difference between "C" and "T" hides; no apparent worm damage.

2nd Trial.—No worm damage, and no visible difference between "C" and "T" hides.

3rd Trial.—Controls free from worm damage, but the delay hides "T" were all worm eaten, although both lots of hides were packed in the same bale; slight smell of putrefaction.

4th Trial.—The delay hides "T" were all badly damaged by worm, whereas only two control hides "C" were slightly worm damaged. The hides marked "T" smelt very strongly of rottenness. Here again both the "C" and "T" hides were packed in one bale.

(*b*) *Lime Yard Report.*

With reference only to putrefaction.

1st Trial. Delay Period, 8 hours

Hide Mark.	Control Hides "C."	Delay Hides "T."
1	Perfectly sound	Very slight putrefaction in one small spot
2	,, ,,	One small patch slightly putrefied
3	,, ,,	Perfectly sound
4	,, ,,	,, ,,
5	,, ,,	Very badly putrefied large patches all over
6	,, ,,	Small white patches on the grain which appeared like putrefaction having started
7	,, ,,	Badly putrefied from flesh side
8	,, ,,	Very badly putrefied on the butt
9	,, ,,	Badly putrefied in three or four places
10	,, ,,	Perfectly sound
	Percentage gain in weight from dry weight to pelt weight 181·6 per cent.	Percentage gain in weight from dry weight to pelt weight 169·0 per cent.

2nd Trial. Delay Period, 16 hours

Hide Mark.	Control Hides "C."	Delay Hides "T."
11	Perfectly sound	Grain damage in small patches
12	,, ,,	Very slight damage just commencing
13	,, ,,	Perfectly sound, very small light hide
14	,, ,,	Perfectly sound
15	,, ,,	Grain damage on surface all over
16	,, ,,	Perfectly sound, a very light thin hide
17	,, ,,	Slight grain damage in patches
18	,, ,,	Surface grain damage more or less all over
19	,, ,,	Grain damage round tail and back bone, also shank
20	,, ,,	Grain damage in patches all over surface, deep
	Percentage gain in weight from dry weight to pelt weight 164·1 per cent.	Percentage gain in weight from dry weight to pelt weight 175·4 per cent.

3rd Trial. Delay Period, 24 hours

Hide Mark.	Control Hides "C."	Delay Hides "T."
21	Very slight putrefaction on head, otherwise perfect	Badly putrefied all over grain and flesh
22	Perfectly sound	Slight putrefaction all over in spots
23	,, ,,	Grain putrefied all over
24	,, ,,	Slight putrefaction on grain
25	,, ,,	Badly putrefied on grain and flesh
26	,, ,,	Badly putrefied on grain
27	,, ,,	Very slight putrefaction on head and down the back bone
28	,, ,,	Badly putrefied round the tail
29	,, ,,	Badly putrefied all over grain and flesh
30	,, ,,	Badly putrefied all over
	Percentage gain in weight from dry weight to pelt weight 183·7 per cent.	Percentage gain in weight from dry weight to pelt weight 158·1 per cent.

4th Trial. Delay Period, 32 hours

Hide Mark.	Control Hides "C."	Delay Hides "T."
31	Perfectly sound	Badly putrefied all over in holes, flesh side and grain
32	,, ,,	Very badly putrefied on flesh side
33	,, ,,	Very badly putrefied all over, mostly from flesh side
34	,, ,,	Slight putrefaction from flesh side
35	,, ,,	Putrefied on flesh side all over
36	,, ,,	Slight putrefaction on flesh side
37	,, ,,	Rotten
38	,, ,,	Rotten
39	,, ,,	Putrefied all over
40	,, ,,	Rotten
	Percentage gain in weight from dry weight to pelt weight 147·5 per cent.	Percentage gain in weight from dry weight to pelt weight 138·0 per cent.

(c) *Report on the Finished Leather.*

With reference only to putrefactive damage.

1st Trial, Delay Period, 8 *hours*

1	Putrefied grain in small spots all over	Exactly the same as control and in the same places
2	Slight spots of putrefaction all over	Spotted with putrefaction more or less all over

1st Trail, Delay Period, 8 hours—(continued).

Hide Mark.	Control Hides "C."	Delay Hides "T."
3	Tender grain in spots	Heavy putrefaction all over grain surface
4	Perfectly sound	Spots of putrefied grain all over
5	,, ,,	Very badly blistered and rotten, only part of the bend left
6	,, ,,	Two small spots of putrefied grain
7	Tender grain	Badly putrefied on flesh side
8	Perfectly sound	Putrefaction just started in the form of spots of tender grain
9	,, ,,	(Missing)
10	(Missing)	(Missing).

2nd Trial. Delay Period, 16 hours

Hide Mark.	Control Hides "C."	Delay Hides "T."
11	Perfectly sound	Putrefied slightly on grain
12	,, ,,	Perfectly sound
13	,, ,,	Slight tender grain
14	Good with the exception of one small spot	Slight putrefaction down the back bone
15	Perfectly sound	Badly blistered grain all over
16	,, ,,	Perfectly sound
17	,, ,,	Fairly sound, small patches of tender grain
18	,, ,,	Badly putrefied grain
19	,, ,,	Badly putrefied grain
20	,, ,,	(Missing).

3rd Trial. Delay Period, 24 hours

Hide Mark.	Control Hides "C."	Delay Hides "T."
21	Perfectly sound	(Missing)
22	Sound except for one small blister	Very badly putrefied in deep blisters
23	Perfectly sound	Very badly blistered all over
24	,, ,,	Badly putrefied grain all over
25	,, ,,	Very badly blistered all over
26	,, ,,	One small spot of tender grain
27	One or two spots of surface putrefaction, very slight	Badly blistered
28	Perfectly sound	Very badly blistered all over
29	,, ,,	Almost useless, so badly putrefied on grain all over
30	,, ,,	(Missing).

4th Trial. Delay Period, 32 hours

Hide Mark.	Control Hides "C."	Delay Hides "T."
31	(Missing)	(Missing)
32	Perfectly sound	Very badly blistered, especially on the flesh
33	,, ,,	Slight tender grain
34	(Missing)	(Missing)
35	Perfectly sound	Very badly blistered
36	Slight tender grain	Badly blistered
37	Perfectly sound	Absolutely rotten, so badly blistered
38	Slight tender grain	(Missing)
39	Perfectly sound	Very badly blistered, almost useless
40	,, ,,	Perfectly sound.

Observations by the Tanner on Hides from Isiolo and Mombasa

In making these reports on the working of the hides from the various trials, no mention has been made of the damage caused by worm. It can be stated, however, that the control hides were practically free from worm damage, except in one or two cases where it was very slight.

The delay hides were badly worm damaged—the worms having attacked these in preference to the control hides, in spite of the control hides being packed in the same bales as the delayed hides, thus being in contact with each other. The longer the delay period the more acute had been the damage to the hides by worm.

With reference to the control hides of both tests, one has only to examine the reports to realise how excellently they have been cured.

Summary of Results of Tanning Trials

With reference to putrefactive damage.

(*a*) *Condition of Hides on Arrival.*—No material differences were observed between the control and the delay hides from both Isiolo and Mombasa, with the exception that the delay hides from 4th trial at Mombasa smelt strongly of putrefaction.

(*b*) *Lime Yard Report.*—See following table.

(*c*) *Report on the Finished Leather.*—See following table.

Delay Period.	Control.		Delay.		
	Perfectly sound.	Slight Putrefaction.	Perfectly sound.	Slight Putrefaction.	Badly Putrefied.
I. Isiolo.					
(*b*) *Lime Yard Pelts*					
8 hours . .	10	0	6	3	1
16 „ . .	10	0	3	4	3
24 „ . .	10	0	2	6	2
32 „ . .	10	0	1	6	3
(*c*) *Finished leather*					
8 hours . .	9	1	4	4	2
16 „ . .	10	0	3	5	1
24 „ . .	8	2	0	5	5
32 „ . .	7	3	1	1	8
II. Mombasa.					
(*b*) *Lime Yard Pelts*					
8 hours . .	10	0	3	3	4
16 „ . .	10	0	3	6	1
24 „ . .	10	0	0	3	7
32 „ . .	10	0	0	2	8
(*c*) *Finished Leather*					
8 hours . .	5	4	0	5	3
16 „ . .	9	1	2	4	3
24 „ . .	8	2	0	1	7
32 „ . .	6	2	1	1	5

Note.—12 bends of finished leather were missing at the final inspection and are not recorded in the summary.

Examination of the Finished Leather

Samples of the finished leather were examined by the British Leather Manufacturers' Research Association. They were subjected to microscopical investigation and physical tests, including resistance to abrasion, with the results given in the following tables.

NOTES ON TERMS AND STANDARDS

Micro-assessment—

8 = Maximum
>5·6 = Very good
5·6 – 5·0 = Good
4·9 – 4·3 = Fair
<4·3 = Poor

Loss on dry abrasion (mm./min.)
<0·35 = Good
0·35 – 0·40 = Fair
>0·40 = Poor

*Q*15 (*mins.*) / *Q*24 (*hours*) = Percentage increase in weight after soaking for 15 minutes and 24 hours respectively.

Free Water Percentage expressed on original sample. It represents the water which a leather will hold at saturation.

I. HIDES FROM ISIOLO TRIALS

(*i*) *Results of Micro-assessment and Abrasion Tests on Finished Sole Bends*

No. of sample.	Period of delay before drying.	Photo-micro-graph No.	Micro-assess-ment.	Average loss (whole thickness) on dry abrasion (mm./min.).	Averages.
Control Hides					
1	None	G681	4·7	0·25	
3	,,	G682	6·2	0·20	
4	,,	G683	5·3	0·32	
8	,,	G684	5·5	0·24	
21	,,	G689	5·2	0·14	
10	,,	G685	5·8	0·16	Micro-assess. = 5·2
12	,,	G686	4·2	0·19	Abrasion = 0·20
26	,,	G690	4·5	0·17	
13	,,	G687	6·7	0·12	
15	,,	G688	4·3	0·20	
29	,,	G691	5·2	0·19	
Delay Hides					
1	8 hours	G692	4·8	0·17	
3	8 ,,	G693	5·3	0·14	*Micro-*
4	8 ,,	G694	4·1	0·23	*assess.* *Abrasion*
8	16 ,,	G695	5·4	0·22	All samples 4·8 0·17
21	16 ,,	G700	4·5	0·18	8 hours 4·7 0·18
10	24 ,,	G696	4·4	0·15	16 ,, 5·0 0·20
12	24 ,,	G697	5·7	0·16	24 ,, 5·4 0·16
26	24 ,,	G701	6·0	0·17	32 ,, 4·1 0·16
13	32 ,,	G698	4·4	0·17	
15	32 ,,	G699	4·3	0·13	
29	32 ,,	G702	3·7	0·19	

(ii) Results of Water Absorption Tests on Finished Sole Bends

Sample.	Thickness (mm.).	Apparent density.		Q15 (mins.).	Q24 (hours).	Free water.	Percentage loss on soaking.	*p*H of water extract.
		Before soaking.	After soaking.					
Control Hides								
1	4·2	1·084	0·898	23·6	22·6	39·8	17·2	4·66
3	4·0	1·082	0·900	19·0	21·3	36·1	14·8	4·62
4	5·3	1·062	0·922	18·3	21·1	34·2	13·1	4·70
8	4·7	1·053	0·893	21·1	21·3	36·6	15·3	4·66
10	3·9	1·098	0·886	17·2	15·7	32·9	17·2	4·58
12	5·0	1·071	0·893	16·4	19·3	35·9	16·6	4·62
13	4·2	1·100	0·926	20·5	22·5	38·2	15·7	4·66
15	4·5	1·035	0·866	22·4	23·1	39·5	16·4	4·68
21	4·5	1·070	0·910	17·4	19·0	33·9	14·9	4·62
26	4·9	1·028	0·890	22·8	22·3	35·8	13·5	4·62
29	5·0	1·019	0·866	22·0	21·1	36·2	15·1	4·70
Av'ge :	4·6	1·064	0·895	20·1	20·8	36·3	15·5	4·65
Delay Hides								
1	4·4	1·049	0·865	24·5	23·9	41·6	17·7	4·66
3	3·8	1·053	0·868	19·4	19·3	36·8	17·5	4·69
4	5·5	1·023	0·870	24·9	25·6	39·0	13·4	4·54
8	4·2	1·152	0·894	16·6	17·4	34·2	16·8	4·62
10	4·5	1·079	0·908	19·8	18·9	34·7	15·8	4·47
12	4·2	1·052	0·872	19·1	20·0	35·2	15·2	4·51
13	4·6	1·098	0·914	16·4	18·3	33·3	15·0	4·53
15	4·2	1·120	0·903	16·5	18·4	33·5	15·1	4·53
21	4·2	1·054	0·868	22·6	21·9	37·7	15·8	4·44
26	5·0	1·050	0·902	21·0	19·4	33·5	14·1	4·50
29	4·4	1·037	0·866	22·2	20·0	36·5	16·6	4·47
Av'ge:	4·5	1·069	0·885	20·3	20·3	36·0	15·7	4·54

II. HIDES FROM MOMBASA TRIALS

Results of Micro-assessment and Abrasion Tests on Finished Sole Bends.

No. of sample.	Period of delay before drying.	Photo-micro-graph No.	Micro-assessment.	Average loss (whole thickness) on dry abrasion (mm./min.).	Averages.
Control Hides					
2	None	G901	5·8	0·18	
3	,,	G902	4·6	0·34	
5	,,	G903	6·2	0·24	
14	,,	G904	5·6	0·29	Micro-assess. = 5·6
17	,,	G905	5·2	0·23	Abrasion = 0·24
22	,,	G906	6·2	0·15	
27	,,	G907	6·5	0·31	
35	,,	G908	5·4	0·21	
40	,,	G909	5·4	0·20	
Delay Hides					*Micro-assess.* *Abrasion*
2	8 hours	G910	5·9	0·20	
3	8 ,,	G911	5·5	0·21	All samples 5·3 0·27
5	8 ,,	G912	5·9	0·41	8 hours 5·8 0·27
14	16 ,,	G913	4·2	0·32	16 ,, 4·8 0·27
17	16 ,,	G914	5·3	0·21	24 ,, 5·1 0·39
22	24 ,,	G915	4·8	0·23	32 ,, 5·6 0·17
27	24 ,,	G916	5·3	0·55	
35	32 ,,	G917	5·2	0·15	
40	32 ,,	G918	6·0	0·19	

(ii) Results of Water Absorption Tests on Finished Sole Bends

Sample.	Thickness.	Apparent Density.		Q15 (mins.).	Q24 (hours).	Free water.	Percentage loss on soaking.	*p*H of water extract.
		Before soaking.	After soaking.					
Control Hides								
2	3·9	1·020	0·886	22·0	24·8	35·6	10·8	4·67
3	4·7	1·009	0·887	20·4	24·6	34·8	10·2	4·67
5	3·9	1·072	0·950	17·0	22·5	34·0	11·5	4·72
14	3·4	1·039	0·935	23·2	23·9	36·5	12·6	4·60
17	3·3	1·045	0·881	26·0	25·3	41·0	15·7	4·62
22	5·5	0·987	0·900	21·4	23·7	32·6	8·9	4·59
27	4·0	1·080	0·927	16·1	20·8	35·0	14·2	4·61
35	4·6	1·040	0·917	20·2	24·1	36·0	11·9	4·66
40	4·4	1·039	0·929	20·2	24·1	34·6	10·5	4·64
Av'ge:	4·2	1·037	0·914	20·7	23·8	35·6	11·8	4·64
Delay Hides								
2	4·5	1·070	0·950	19·0	24·2	35·3	11·1	4·66
3	5·2	1·003	0·931	22·6	26·7	33·8	7·1	4·44
5	4·7	1·067	0·939	16·8	25·0	37·6	12·6	4·36
14	3·5	1·027	0·910	25·5	26·2	37·5	11·3	4·37
17	3·4	1·059	0·892	25·1	24·7	40·5	15·8	4·30
22	5·5	1·052	0·959	15·1	23·0	31·8	8·8	4·41
27	4·0	0·993	0·869	19·1	23·6	40·6	17·0	4·38
35	4·5	1·037	0·946	19·3	23·1	33·9	10·8	4·33
40	3·9	1·022	0·898	26·2	25·9	35·8	9·9	4·28
Av'ge:	4·4	1·037	0·912	21·0	24·7	36·3	11·6	4·39

Very little difference, either as regards condition of fibre-structure as judged from photomicrographs, or quality of leather as judged by its resistance to abrasion, is shown in either experiment between control and delay hides, or between the batches of hides representing varying periods of delay.

In the Isiolo experiment the average microscopical assessment figure for the leathers where the drying of the hides had been delayed for 32 hours is definitely lower than in any of the other groups, but the results of the abrasion tests did not suggest any loss of wearing quality.

With reference to water-absorption properties, there were no significant differences between the leathers from the control and delay hides. The figures for Q15, Q24 and Free Water are within reasonable limits.

Conclusions

The results obtained in the tannery as seen in the report on the pelts in the limed state and also in the report on the finished leather, for the hides from both sets of trials (Isiolo and Mombasa) showed very distinctly that putrefactive damage increased with the length of the delay period before drying the hides, and that even the shortest delay period (8 hours) observed in these trials caused serious damage. On the other hand the control hides which were suspended for drying within 2 hours of flaying were much freer from putrefactive damage, but some cases of slight damage were seen in the finished leather, though they were not noticeable in the pelt stage.

Delay under humid conditions at Mombasa appeared to be rather more conducive to putrefactive damage than the drier conditions at Isiolo.

The laboratory examination showed little difference between the leathers from the control and delay hides in respect of fibre structure of the corium, resistance to abrasion and water absorption.

The effect of delay before drying is to set up putrefaction in the hide. Another well-marked result has been observed in these trials, viz. whereas the control hides were practically free from grub damage, or showed only slight attack, the delay hides were badly damaged, in spite of the fact that both control and delay hides were packed in the same bale for transport. The longer the delay period the more severe had been the grub damage.

It would appear that the hide beetle and larvæ attack hides showing putrefaction in preference to hides free from putrefactive damage.

To sum up, these trials show that serious putrefactive damage may occur when there is a delay of 8 hours between flaying and suspending the hide for drying, under both dry and humid climatic conditions. Suspension for drying within 2 hours of flaying gives much greater freedom from putrefaction.

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A Quantitative Investigation of the Steeping Method for the Preservation of Timber. A Modern Application of an Old Process to Australian Mine Timbers. By H. B. Wilson and J. N. Gregory. *J. Coun. Sci. Industr. Res. Aust.*, 1941, **14**, 281-287.

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IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 18

(January to March 1942)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

GENERAL

Ann. Rep. Dep. Agric., Queensland, 1940-41, p. 7. Refers to use of nicotine dusts for control of banana rust thrips, and to experiments with paraffin-pyrethrum spray for treating insect infestation of stored pea-nuts.

Rep. Minist. Agric. Canada for year ending March 31, 1941, pp. 46-48. Nicotine sulphate, pyrethrum powder, or pyrethrum extracts in combination with suitable wetting agents gave control for the mullein leaf bug, an apple pest in Nova Scotia. References to the use of nicotine in sprays against codling moth—not so effective as lead arsenate; satisfactory against eye-spotted budmoth; " fixed-nicotine " mixture developed which is effective and easy of removal from fruit at harvest; diesel oil emulsion and powdered derris root against the European red mite.

Experiments with Insecticides in 1940. *Ann. Rep. Nova Scotia Fruit Growers' Assoc.*, 1940, pp. 29-33. Experiments with various oil and nicotine sprays alone or in combination with derris and other materials applied to dormant trees indicated that no single material or combination was equally effective in control of orchard insects.

Rep. Dep. Agric. Nova Scotia, 1940, pp. 83-93. (*Amer. Chem. Absts.*, 1942, **36**, No. 1, 209.) Nicotine, pyrethrum and derris sprays in combination with a wetting agent gave good control of the mullein bug.

Ann. Rep. East African Agricultural Research Station, Amani, for 1940. References to work on *Millettia* sp. and Derris, pp. 5, 15, 17.

Rep. S. Carolina Exp. Sta., 1939-40, pp. 60-68, 121-127. Describes experiments on the control of the tomato fruitworm *Heliothis armigera* with various insecticides including derris. (*R.A.E.*, 1942, **30**, A, Pt. 1, 42-43.) Also with pyrethrum and rotenone against the corn earworm; nicotine, derris or cube tested to control aphids on cotton; rotenone superior to nicotine.

Bulletin of the Bartlett Tree Research Laboratories, Stamford, Connecticut, 1939. Records experiments on the control of *Phytomyza ilicicola* with lead arsenate and nicotine sulphate sprays, club gall of dogwood with cube spray and insects on rhododendrons with nicotine. (*R.A.E.*, 1941, **29**, A, Pt. 12, 606.)

Report on Insect Investigations for the 1938 Season. *Bull. No.* 433, *Conn. Agric. Exp. Sta.*, pp. 186-193. (*R.A.E.*, 1942, **30**, A, Pt. 1, 40.) Experiments on shade-grown tobacco with dusts and sprays containing cube or pyrethrins against *Epitrix cucumeris* and *Frankliniella fusca* described.

Entomological Progress No. 2. *Bull. No.* 323, *Louisiana Agric. Exp. Sta.*, 1940. (*R.A.E.*, 1941, **29**, A, Pt. 12, 599.) Dusts of nicotine, derris or pyrethrum less effective than arsenicals or cryolite for control of corn silk beetle; derris dust gave little control of *Colias eurytheme* on lucerne, etc.; derris or cube dust satisfactory against Mexican bean beetle; pyrethrum, rotenone or nicotine sulphate added to soap spray only slightly increases control of pentatomids attacking tomatoes; nicotine-lime dust for control of squash bug.

Report of the Massachusetts Agricultural Experiment Station for 1939. (*R.A.E.*, 1942, **30**, A, Pt. 2, 76.) Nicotine sulphate emulsion or derris spray reduced the infestation of squash by the borer *Melittia satyriniformis* but dusts not so effective; cube with talc and a rotenone dust effective against the beetles on cucumbers; tests also carried out with control of onion thrips with nicotine sulphate, rotenone and derris, against potato aphis with nicotine sulphate, on the European corn borer with derris and cube, and red spider on roses under glasshouse conditions with derris and cube.

Report of the Cranberry Station, East Wareham, Massachusetts, for 1939, pp. 33-38. (*R.A.E.*, 1942, **30**, A, Pt. 2, 75.) Dusting with derris or mixtures of derris and pyrethrum failed to control the larger larvæ of *Lymantria dispar*; sprays and dusts of rotenone-containing materials satisfactory against *Mineola vaccinii*; derris dusts used for control of *Rhopobota* and *Ophiola*.

Ann. Rep. New York Agric. Exp. Sta. for the year ended June 30, 1941. Fruit and vegetable insect investigations involving the use of nicotine, derris and pyrethrum are detailed; for aphids on hops nicotine sulphate successful; dust comprising proprietary compound, sulphur and derris effective against downy mildew, red spider and Mexican bean beetle on lima beans.

Progress of Agricultural Research in Ohio, 1937-38. *Bull.* 600, *Ohio Agric. Exp. Sta.*, 1939, p. 30. (*R.A.E.*, 1942, **30**, A, Pt. 2, 53.) Dusts containing derris, pyrethrum powder and those impregnated with pyrethrum extract were tested against *Pieris rapæ* on cabbage.

Field Studies of Insecticides Used to Control Cabbage Caterpillars in the South. By W. J. Reid, C. E. Smith, I. B. Reed, and W. A. Thomas. *Tech. Bull. No.* 782, *U.S. Dep. Agric.*, 1941. The materials tested consisted of various dilutions of derris powder, pyrethrum powder, hellebore, tobacco dust, and a number of inorganic compounds. Derris dust gave the most satisfactory results.

Experiments on Controlling the Rice Borer with Insecticides. 1. Field Experiments with various kinds of Dosages of Insecticides. By K. Kuwazuka, K. Ogusa and N. Ando. *Extra Rep. Aichi Agric. Exp. Sta., Japan*, 1940. (*R.A.E.*, 1942, **30**, A, Pt. 1, 11.) Refers to results obtained with nicotine and with pyrethrum against *Chilo simplex*.

Studies on *Pyraustia nubilalis* Hübner attacking the Cotton Plant. By M. Koo. *Yamanashi Agric. Exp. Sta., Japan*, 1940. (*R.A.E.*, 1942, **30**, A, Pt. 1, 16.) Derris and tobacco tested for prevention of oviposition; not satisfactory.

Control Experiments with *Penthaleus hæmatopis* Koch. which occurred in Ibarugi Prefecture. By I. Tamura. *Agric. and Hort., Japan*, 1940, **15**, 2280-2286. (*R.A.E.*, 1942, **30,** A, Pt. 1, 10.) Sprays of soap solution containing pyrethrum, derris, nicotine sulphate, or fish oil effective in killing the mites.

On the Chestnut Bark Miner *Acrocercops* sp. By A. Kawada and H. Suenaga. *Oyo Kontyu, Tokyo,* 1940, **2,** No. 6, 240-255. (*R.A.E.*, 1942, **30,** A, Pt. 1, 16.) Nicotine sulphate or pyrethrum and soap recommended for control.

Laboratory Control Studies on the Greenhouse Thrips *Heliothrips hæmorrhoidalis.* By B. R. Bartlett and C. O. Persing. *J. Econ. Ent.*, 1941, **34,** No. 6, 760-766. Pyrethrum, nicotine sulphate, nicotine-bentonite mixture and derris extract were among the products tested.

Control of the American Strawberry Leafroller during 1939. *Bienn. Rep. Kansas Hort. Soc.*, 1940, **45,** 181-186. (*R.A.E.*, 1941, **29,** A, Pt. 12, 633.) Experiments with nicotine sulphate and pyrethrum.

A Flower-spot Disease of Cultivated Azaleas. By F. Weiss and F. F. Smith. *Circ. No.* 556, *U.S. Dep. Agric.*, 1940. (*R.A.E.*, 1942, **30,** A, Pt. 2, 50.) Standard contact dusts containing derris, pyrethrum or nicotine sulphate had no effect on insects which transmit the disease ; most favourable results obtained with a bait containing cane-sugar and derris powder on tartar emetic.

Culture, Diseases and Pests of the Box Tree. By F. Weiss and L. G. Baumhofer. *Frms'. Bull. No.* 1855, *U.S. Dep. Agric.* Nicotine sulphate sprays and derris sprays recommended.

Mushroom Pests and Their Control. By A. C. Davis. *Circ. No.* 457 (*Revised*), *U.S. Dep. Agric.*, 1941, pp. 17-18, 25, 26. Use of pyrethrum dusts and drenches for mushroom fly and meal moth control and nicotine-lime dust against springtails.

The Control of Tomato Pests. By W. J. S. Sloan. *Queensld. Agric. J.*, 1941, **56,** 277-294. Nicotine dust checks jassids, and aphids are controlled by nicotine dust or spray ; derris spray of some value against nymphs of shield bugs and nicotine dust against the bugs ; nicotine and pyrethrum partially effective against the Rutherglen bug.

The Turnip Aphid in the Southern States and Methods for its Control. By N. Allen and P. K. Harrison. *Frms'. Bull. No.* 1863, *U.S. Dep. Agric.*, 1941. Dusts of derris or cube or of nicotine sulphate are recommended and good results obtained with a spray of finely ground derris or cube root. (*R.A.E.*, 1941, **29,** A, Pt. 12, 596.)

Pea Aphid Control in Oregon. By K. W. Gray and J. Schuh. *Bull. No.* 389, *Oregon Agric. Exp. Sta.*, 1941. (*Exp. Sta. Rec.*, 1941, **85,** No. 6, 791.) Materials tested included dusts containing rotenone, pyrethrins, nicotine ; one containing rotenone and soybean oil most effective for control.

The Pistole Case-bearer and Its Control in Pennsylvania Orchards. By H. M. Steiner and H. N. Worthley. *Bull. No.* 406, *Pennsylvania Agric. Exp. Sta.*, 1941. Midsummer sprays of oil-nicotine or nicotine-penetrol efficacious ; two early applications of cube powder most effective.

Solving Utah Canning Crop Problems. *Publ. Utah Agric. Coll. Ext. Serv.*, 1941. (*R.A.E.*, 1941, **29,** A, Pt. 12, 630.) Rotenone dusts and treatment with nicotine vaporiser effective for the control of pea aphid ; tobacco dust gave fair results against the tomato fruit worm.

Toxicants Used with Petroleum Oil Sprays for Deciduous Fruits. By L. M. Smith. *J. Econ. Ent.*, 1941, **34,** No. 6, 844-851. Reviews the position with regard to nicotine, anabasine, pyrethrins I and II, rotenone, rotenoids, quassia and veratrin alkaloids.

Materials Added to Oil Spray to Increase Its Effectiveness in Citrus Pest Control. By W. Ebeling. *J. Econ. Ent.*, 1941, **34,** No. 6, 829-837. Pyrethrum, nicotine, rotenone-bearing powders, rotenone and total extractives of rotenone-bearing plants mentioned.

Relative Effectiveness of Acid Lead Arsenate and other Materials as Stomach Poisons for the Larvæ of the Japanese Beetle (*Popillia japonica*).

By W. E. Fleming. *Tech. Bull. No.* 788, *U.S. Dep. Agric.* Derris, hellebore, mowrah meal, pyrethrum and rotenone were tested and it was apparent that these materials have no practical value as substitutes for acid lead arsenate in the soil.

Effect of Wetting Agents in increasing the Efficiency of Sprays used in Control of Japanese Beetle. By G. F. McKenna and A. Hartzell. *Contr. Boyce Thompson Inst.*, 1941, **11**, No. 6, 465-471. (*R.A.E.*, 1941, **29**, A, Pt. 12, 595.) Sprays containing pyrethrum resin or rotenone were experimented with.

List of Publications and Patents of the Division of Insecticide Investigations, United States Department of Agriculture, for the period January 1, 1940, to December 31, 1941.

The Analysis of Toxicity Tests on Mixtures of Poisons. By D. J. Finney. *Ann. Appl. Biol.*, 1942, **29**, No. 1, 82-94.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Nicotine. A Product of Tobacco. By G. M. Ward. *Publ. No.* 730, *Dep. Agric. Canada.* Discusses the preparation and extraction of nicotine on a commercial basis, its use as an insecticide and the extent of the domestic market for nicotine products.

Ann. Rep. Dep. Agric. Ceylon, 1939, p. D20. (*R.A.E.*, 1941, **29**, A, Pt. 12, 594.) Nicotine sulphate and soap gave control of leaf-mining larvæ of *Aristotelia* sp. attacking soy beans.

Ann. Rep. Del. Agric. Sta., 1940, *Bull. No.* 227, pp. 30-34. Refers to experiments on the use of nicotine sulphate as an ovicide of the plum curculio. (*R.A.E.*, 1942, **30**, A, Pt. 1, 38.)

Report of the Hawaii Agricultural Experiment Station for 1940, pp. 38-45. Nicotine sulphate recommended for inclusion in routine spray for insects attacking potatoes.

The Pros and Cons of Nicotine Sprays in the Apple Schedule. By D. B. Perrine. *Illinois St. Hort. Soc. Trans.*, 1940, **74**, 159-164.

The Celery Fly. *Adv. Leafl. No.* 87, *Minist. Agric. Lond.*, p. 2. Nicotine wash recommended for control of larvæ.

Codling Moth Studies in North-east Kansas and North-west Missouri during 1939. *Bienn. Rep. Kansas Hort. Soc.*, 1940, **45**, 187-196. (*R.A.E.*, 1941, **29**, A, Pt. 12, 633.) Describes field tests carried out with nicotine-bentonite sprays.

A New Kind of Codling Moth Control. By A. Van Alstyne. *Proc. N. Y. St. Hort. Soc.*, 1941, **86**, 328-330. (*R.A.E.*, 1941, **29**, A, Pt. 12, 96.) Nicotine included in the sprays.

Dusting and Spraying for the Control of Insect Pests of the Irish Potato. By J. R. Eyer and J. V. Enzie. *Bull. No.* 266, *New Mexico Agric. Exp. Sta.*, 1939. (*R.A.E.*, 1941, **29**, A, Pt. 12, 638.) Nicotine sulphate sprays used against the nymphs and adults of *Empoasca abrupta.*

Observations on the Biology and Control of the Treehopper *Heliria præalta* Fowler in the Orchards of the Pacific Northwest. By M. A. Yothers and P. B. Allen. *Circ. No.* 606, *U.S. Dep. Agric.* Nicotine sprays effective.

Millipedes and Centipedes. *Adv. Leafl. No.* 150, *Minist. Agric. Lond.* Refers to use of nicotine for control in glasshouses.

The Sugarcane Borer. By J. W. Ingram and E. K. Bynum. *Frms'. Bull. No.* 1884, *U.S. Dep. Agric.*, p. 16. Dual-fixed nicotine failed to give satisfactory control of *Diatræa saccharalis.*

A possibilidade da transmissão de doencas de virus pelas pulverisações com extractos de fumo. By K. Silberschmidt and M. Kramer. *Biologico,* 1941, **7**, No. 8, 207-215. Abst. in *Rev. Appl. Mycol.*, 1942, **21**, Pt. 2, 102.

The possibility of virus disease transmission by spraying with tobacco extracts.

Insects which Attack the Redbud. *Bienn. Rep. Kans. Hort. Soc.*, 1940, **45**, 239-242. (*R.A.E.*, 1941, **29**, A, Pt. 12, 635.) Nicotine sulphate recommended for control of aphids.

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

Fiftieth Annual Report of the Washington Agricultural Experiment Station for the year ended June 30, 1940, pp. 42-47. (*R.A.E.*, 1941, **29**, A, Pt. 1, 640.) Spray containing lead arsenate and rotenone no more effective against codling moth than lead arsenate alone; rotenone effective against mites in orchards; infestation by the cherry fruitworm reduced by rotenone sprays but did not control the flies.

Report of the Chief of the Office of Experiment Stations, United States Department of Agriculture, 1941, p. 6-7. Refers to the progress of research carried out on the production of insecticides, especially derris and lonchocarpus.

The Problem of the Evaluation of Rotenone-containing Plants. VI. The Toxicity of l-Elliptone and of Poisons Applied Jointly, with further observations on the Rotenone Equivalent Method of Assessing the Toxicity of Derris Root. By J. T. Martin. *Ann. Appl. Biol.*, 1942, **29**, No. 1, 69-81.

Kerosene-Rotenone Spray for Red Scale. By H. J. Quayle. *Calif. Citrog.*, 1941, **26**, No. 11, 319. (*Exp. Sta. Rec.*, 1942, **86**, No. 2, 218.)

Rotenone and Oil Sprays: Some Observations on Use of Toxic Materials in Control of Scale Pests. By I. G. McBeth and J. R. Allison. *Calif. Citrog.*, 1941, **26**, No. 10, 282, 310-311. (*Exp. Sta. Rec.*, 1942, **86**, No. 2, 218.)

Observations on Rotenone and Oil Sprays for Red Scale. By I. G. McBeth and J. R. Allison. *Citrus Leaves*, 1941, **21**, No. 8, 7-8, 26. (*Amer. Chem. Absts.*, 1942, **36**, No. 1, 210.)

Solubilizers for Petroleum Oils and Extracts of Rotenone-bearing Roots. By J. F. Kagy and A. M. Boyce. *J. Econ. Ent.*, 1941, **34**, No. 6, 804-811.

The Value and Relative Effectiveness of Preparations of Rotenone, Derris Powder and Cube Powder as Larvicides for Cattle Grubs. By C. E. Smith, E. Livengood and I. H. Roberts. *J. Amer. Vet. Med. Ass.*, 1941, **99**, No. 776, 391-394. (*R.A.E.*, 1942, **30**, B, Pt. 1, 10.)

The Alfalfa Snout Beetle. Its Control and Suppression. By C. E. Palm, C. Lincoln and A. B. Buchholz. *Bull. No.* 757, *Cornell Agric. Exp. Sta.*, p. 32. Rotenone dusts tested but best control obtained with poisoned baits.

The Citrus Bud Mite, *Eriophyes sheldoni* Ewing. By A. M. Boyce and R. B. Korsmeier. *J. Econ. Ent.*, 1941, **34**, No. 6, 745-756. Oil sprays containing rotenone only fairly effective against citrus bud mite or citrus red mite but satisfactory in black scale control.

The European Earwig. By S. E. Crumb, P. M. Eide and A. E. Bonn. *Tech. Bull. No.* 766, *U.S. Dep. Agric.*, pp. 50-58. Refers to various products including rotenone used as attractants and poisons in experiments.

Studies on the Importance and Control of the Tobacco Flea Beetle. By N. Allen. *Rep. S. Carolina Exp. Sta.*, 1939-40, pp. 131-138. Cube or derris tested and gave satisfactory results. (*R.A.E.*, 1942, **30**, A, Pt. 1, 44.)

Effect of Soft Glass on the Melting Point of Rotenone. By H. A. Jones. *Industr. Eng. Chem., Anal. Ed.*, 1941, **13**, 819. (*Amer. Chem. Absts.*, 1942, **36**, No. 1, 210.)

Derris

Report to the League of Nations on the Administration of the Territory of New Guinea from July 1, 1939, to June 30, 1940. Brief reference to the extension of the cultivation of *Derris elliptica* in New Guinea.

Notes on Agricultural Development in British Guiana, by the Inspector-General of Agriculture in the West Indies. *Legis. Coun. Pap. No.* 7, 1941, *Brit. Guiana,* p. 24. Possibility of cultivating derris on the pegasse soils of the Pomeroon referred to.

Report of the Minister of Agriculture, Ontario, for 1940-41. Refers to promising results obtained by spraying sweet corn with derris (4 per cent. rotenone) for the control of the corn borer.

Dutch Indies Derris Root. *Chem. Tr. J.*, 1942, **110**, 154. Area under cultivation and exports for 1939 and 1940.

Derris in Guatemala. *Chem. Tr. J.*, 1942, **110**, 306. Experiments being carried out.

Draagstof voor derrispoeder. By F. A. T. H. Verbeek. *Bergcultures,* 1941, **15**, 1493-1497. Carriers for derris powder are discussed.

A Review of Some Recent Entomological Investigations and Observations. By C. H. Corbett and H. T. Pagden. *Malay. Agric. J.*, 1941, **29**, No. 9, 347-375. Refers to work carried out on spraying and dusting technique with derris.

Studies on the Control of Cabbage Caterpillars with Derris in the South. By W. J. Reid, C. E. Smith, L. B. Reed and C. O. Bare. *Circ. No.* 615, *U. S. Dep. Agric.*

Boll Weevil and Cotton Aphid Control by Use of Derris in Combination with Calcium Arsenate. By C. F. Rainwater and F. F. Bondy. *J. Econ. Ent.*, 1941, **34**, No. 6, 733-735.

Action of Derris and Rotenone on the Firebrat (*Thermobia domestica* Packard). By C. H. Richardson and E. J. Seiferle. *J. Econ. Ent.*, 1941, **34**, No. 6, 860-861.

Bestrijding van *Helopeltis* in Thee door middel van Derrisstuifmengsels. By F. A. T. H. Verbeek. *Bergcultures,* 1942, **16**, 30-32. Control of *Helopeltis* on tea by dusting with derris mixtures.

Notes on the Oriental Migratory Locust (*Locusta migratoria manilensis* Meyer) with special reference to its Solitary Phase and Breeding Place on Outbreak Area. By F. Q. Otanes. *Philipp. J. Agric.*, 1940, **11**, No. 4, 331-353. (*R. A.E.*, 1942, **30**, A, Pt. 1, 19.) Fine derris dust lethal to hoppers and adults.

Derris Dust for Control of Cucumber Insects. By C. Lyle. *Miss. Farm Res.*, 1940, **3**, No. 4, 1940. (*R. A.E.*, 1941, **29**, A, Pt. 12, 647.)

Lonchocarpus

Susceptibility of Resistant and Non-resistant Strains of the California Red Scale to Sprays of Oil and Cube Resins. By A. W. Cressmann. *J. Econ. Ent.*, 1941, **34**, No. 6, 859.

PYRETHRIN-CONTAINING MATERIALS

Breeding Pyrethrum for Insecticides. By B. M. Greener. *Proc. Lenin Acad. Agric. Sci. U.S.S.R.*, 1941, No. 6, 13-16. (*Plant Breed. Absts.*, 1942, **12**, No. 1, 371.)

Cultuuraanwijzingen voor Pyrethrum. *Landbouw,* 1941, **17**, 255-257. (*Hort. Absts.*, 1941, **11**, No. 4, 327.) The cultivation of pyrethrum with special reference to Java.

Reports of the Bulgarian Agricultural Association for 1937 and 1938. *Zemledelie, Sofia,* 1938, **42**, No. 4, 5-31; 1939, **43**, No. 4, 1-25. (*Plant Breed. Absts.*, 1942, **12**, No. 1, 16-17.) Summarises the research work carried out on pyrethrum breeding.

Harvesting Pyrethrum Flowers. By H. C. Arnold. *Rhod. Agric. J.*, 1941, **38**, 597-598.

Pyrethrum in South Africa. *Foreign Comm. Wkly,* 1942, **6**, No. 5, 17. Note on the imports of pyrethrum into the Union of South Africa.

Lethal Effects of Contact Insecticides upon Insect Eggs. I. Pyrethrin. By H. Mori. *Oyo Dobuts. Zasshi, Tokyo,* 1940, **12,** No. 5-6, 209-214. (*R. A. E.* 1942, **30,** A, Pt. 1, 17.) Describes tests on eggs of *Chilo simplex.*

The Use of Pyrethrum Powder in Colloidal Solution as a Larvicide. By H. M. Jettmar. *Chin. Med. J.,* 1941, **59,** No. 6, 565-569. (*R. A. E.,* 1942, **30,** B, Pt. 1, 16.) Tested on larvæ and pupæ of *Culex* and *Armigeres.*

The Control of Ants. By G. J. Broehuysen. *Frmg. S. Afr.,* 1941, **16,** 23-26, 28. (*R. A. E.,* 1942, **30,** A, Pt. 2, 88.) Spraying with atomised mixture of pyrethrum and kerosene recommended for controlling the brown house ant, and soapy water containing 0·1 per cent. pyrethrum extract for dealing with the nests of *Camponotus.*

On the Control of *Adelges japonicus* Monzen. By M. Inouye. *Circ. Hokkaido For. Exp. Sta., Japan,* 1940. (*R. A. E.,* 1942, **30,** A, Pt. 1, 14.) Use of pyrethrum with emulsions of petroleum oil effective.

Non-arsenical Dusts for Cauliflower and Cabbage Worm Control on Long Island. By H. O. Huckett. *Bull. No.* 695, *N. Y. Agric. Exp. Sta.* (*R. A. E.,* 1942, **30,** A, Pt. 2, 59.) Pyrethrum dusts easier to apply successfully than impregnated pyrethrin dusts.

Bed-bug Insecticides. *Chem. and Drug.,* 1942, **137,** 355. Formulæ recommended by the Bed-bug Infestation Committee of the Medical Research Council for use in air-raid shelters. Includes a pyrethrin-in-kerosene spray.

Clover Leafhopper (*Aceratagallia sanguinolenta* Prov.). By T. C. Watkins. *Bull. No.* 758, *Cornell Agric. Exp. Sta.,* 1941. (*Exp. Sta. Rec.,* 1942, **86,** No. 2, 217.) Bordeaux and pyrethrum spray satisfactory, also pyrethrum dust effective for control.

Ann. Rep. Colorado Exp. Sta., 1939-40. (*R. A. E.,* 1941, **29,** A, Pt. 12, 597.) Refers to the effectiveness of pyrethrum dust against the squash bug *Anasa tristis.*

Poison for Silverfish. *E. Afr. Agric. J.,* 1942, **7,** 126. Pyrethrum effective.

Treatment of Scabies and Pediculosis with Pyrethrum. By D. N. Roy, G. M. Ghosh and Sir R. N. Chopra. *Indian Med. Gaz.,* 1941, **76,** No. 6, 333-335. (*R. A. E.,* 1942, **30,** B, Pt. 1, 1.)

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Insecticide Suitable for Combatting Japanese Beetles, etc. By I. M. Colbeth. *Amer. Chem. Absts.,* 1942, **36,** No. 1, 212. Made from the distillate obtained by dry-distillation of castor oil.

Estudo químico do oleo pardo (Essencia de *Myrocarpus sylvestris*). Emprego em perfumaria, em medicina e como insecticida. By A. Machado. *Rev. Quim. Industr., Brazil,* 1941, **10,** No. 112, 14. An essential oil, used as an insecticide.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

AGRICULTURE IN THE WEST INDIES. The Colonial Office, Colonial No. 182. Pp. vi + 280, 9¾ × 6. (London: His Majesty's Stationery Office, 1942.) Price 10s.

The basis of this official publication was provided by statements and returns prepared in response to a special questionnaire relating to agriculture issued to all West Indian Colonies by the West India

Royal Commission, 1938-39. The work has been compiled by Dr. H. A. Tempany; the various sections as completed have been examined by Professor Engledow, a member of the Royal Commission, and also sent to the Colony concerned for final revision. Thus every endeavour has been made to provide a comprehensive and accurate account of the position of agriculture in these Dependencies at the outbreak of war. Present circumstances have delayed the actual appearance of this account.

Altogether Dr. Tempany has been responsible for a most useful publication which will be of great value to all concerned with the welfare of the West Indies, and more particularly the agricultural development of these territories. The account contains much information that is commonly not readily available from annual reports, e.g. the present position of local ancillary industries, and it forms a type of publication that would be widely appreciated if one could be prepared and occasionally brought up to date for all groups of Colonies. As regards the subject matter, the work opens with a short historical survey of West Indian agriculture. Subsequent chapters deal with the agriculture of the several Dependencies in turn, viz., Jamaica, Trinidad and Tobago, British Guiana, Barbados, Windward Islands (Grenada, St. Vincent, St. Lucia and Dominica are separately considered), Leeward Islands, and British Honduras. The work is completed by short accounts of agricultural education and intra-colonial agricultural organisations, a brief summary, and a few statistical appendices.

Agriculture in the West Indies has had to contend at one time or another with a number of adverse circumstances. Sugar cane, always the staple crop, and to which this account can suggest no serious alternative, has been dealt several severe blows. In recent years disease incidence (Panama, *Cercospora* and Witchbroom) has been severe with bananas and cacao. The occurrence of serious calamities have been all too frequent in the history of West Indian agriculture, e.g. the collapse of the Dominica lime industry from an export total equivalent to some 500,000 barrels of limes in 1920 to a mere equivalent of some 27,000 barrels in 1934. It is perhaps permissible to wonder whether more may perhaps be possible in the future in the way of anticipating and hence to some extent mitigating the effects of such abrupt changes of fortune.

It is shown how well the West Indies have been provided with scientific and technical services since the inception of the former Imperial Department of Agriculture, the success of which led to the development of agricultural services in the Colonial Empire as a whole. This group of Colonies is fortunate in having the Imperial College of Tropical Agriculture in Trinidad, which includes a Low Temperature Research Station, and an Advisory Department more particularly concerned with the supervision of technical work in the smaller Dependencies; cacao research on behalf of Empire countries is also undertaken. A West Indian Sugar Cane Breeding

Station is situated in Barbados, while also in Trinidad is the Empire Cotton Growing Corporation's Research Station.

Much remains to be done in the West Indies in developing local food production and animal husbandry with a view to making these territories less affected by changes in the demand for export commodities. It is recognised that increased attention will have to be paid to the needs of small farmers, and in the view of Sir Frank Stockdale, who has written the preface, " it is essential that a greater measure of community education should be provided, if the results of investigation and research are to be translated into practice and the agricultural activities of smallholders improved." Thus the present need in the West Indies would appear to be for further development of extension services.

THE INDUSTRIAL CHEMISTRY OF THE FATS AND WAXES. By T. P. Hilditch, D.Sc., F.I.C. Second Edition, revised and enlarged. Pp. xi + 532, 8½ × 5½. (London: Baillière, Tindall & Cox, 1941.) Price 25*s*.

This book was first published as one of a series of textbooks on industrial chemistry. The second edition now appears as a separate monograph. It follows the same general lines as the first edition, but as is to be expected after a lapse of fourteen years it covers more ground. Advances in technology include improvements in refining processes and in the manufacture of margarine, the entry into the field of new fatty oils and of various synthetic and " semi-synthetic " materials, and an entirely new chapter deals with " soapless detergents."

The revision, however, has been somewhat uneven. Thus the section on fatty lubricants remains unaltered, even the bibliography referring to the third edition (1912) of Archbutt and Deeley's *Lubrication and Lubricants*, a standard work now in its fifth edition (1927). There is no account of the use of fatty oils as fuel in internal combustion engines.

But the book is not designed to be an exhaustive treatise. To quote the introductory chapter, " it is rather concerned to show as far as possible how the chemical constitution of definite fats is connected with particular utility either of the fat or of its constituent fatty acids in different industries." The bibliographies at the end of each section are intended to assist students and others to pursue in greater detail such questions as may relate to their particular problems.

THE COMPOSITION OF THE DEPOT FATS OF AQUATIC ANIMALS. By J. A. Lovern, D.Sc., Ph.D., F.I.C. Department of Scientific and Industrial Research, Food Investigation, Special Report No. 51. Pp. iii + 72, 9½ × 6. (London: His Majesty's Stationery Office, 1942.) Price 1*s*. 6*d*.

This Report deals with fats stored as reserves in various parts of their bodies by aquatic animals, the term " aquatic " being limited in the main to creatures spending their whole lives in water (mussels, fish, both of fresh and salt water, whales and their allies and certain sea-birds). Laboratory methods of investigation are described fully and the interpretation of results is considered in detail. All available data relating to the fats of aquatic animals are collected, with copious references to original sources of information, and a number of theoretical questions of biochemical interest are discussed.

TANNIN ANALYSIS. Edited by D. McCandlish, M.Sc. Pp. 18, 8½ × 5½. (A. Harvey, Publisher, 3 Stafford Court, Waddon, Croydon, 1942.) Price 1s. 6*d.*

This small booklet, with stiff covers, is a very handy form in which to have for practical use the Provisional Official Method of Quantitative Tannin Analysis of the British Section of the International Society of Leather Trades' Chemists, which was operative from January 1, 1942.

As in previous statements of the official method, the General Regulations comprise descriptions of apparatus, with several efficient drawings, the preparation of samples for analysis, both crude materials and extracts, and the actual operations for determining moisture, total solids, solubles and non-tannins, and for the measurement of colour.

In the foreword Professor McCandlish explains why the British Section now issues its own method; in view of the failure of the international co-operative effort this section proposed in 1939 that the official international method should be replaced by the 1926 method with certain modifications, but owing to the outbreak of war the proposal was not proceeded with. The present description represents the views of the British Section and is an alternative method to the current official method of the International Society, which can only be altered by a conference of the full society.

MANUAL OF INDIAN FOREST UTILISATION. By H. Trotter, I.F.S. Pp. viii + 419, 9¾ × 7½. (London: Humphrey Milford, Oxford University Press, 1940.) Price 30*s.*

This book was printed in India and has now become available in this country, hence the apparent time lag between the date of publication as printed on the title page and the appearance of a review. It is not intended as a complete treatise on forest utilisation in all its aspects, but rather as an elementary manual for the use of Indian Forest Ranger students. Although based to a large extent on Troup's *Indian Forest Utilisation*, the second edition of which appeared 30 years ago, it contains so much additional, up-to-date material that it is in effect a new work. Not only has great progress been made in wood utilisation and in minor forest products since Troup revised his manual in 1912, but such subjects as kiln seasoning, timber testing, wood technology and wood preservation were then unknown in India.

Part I of the Manual, occupying nearly one-half of the book, deals with the utilisation of wood and includes accounts of the anatomical structure and properties of wood, felling and conversion, transport and storage, disposal and sale, organisation of forest labour and particulars of the innumerable uses to which Indian woods may be put. Part II covers important auxiliary utilisation industries such as the seasoning and preservation of timber, and sawmills and wood workshops. The utilisation of minor forest products (fibres, bamboos, essential oils, oilseeds, tans and dyes, gums and resins, drugs, etc., etc.) is dealt with in Part III, whilst Part IV describes important minor forest products industries (lac, resin-tapping and distillation, charcoal burning, pulp- and paper-making, etc.). A key is given for the identification of thirty important Indian timbers and there are a number of appendices giving marking rules, contract forms, specifications and other matters of interest to the Indian forester.

The book is excellently produced and contains a number of diagrams and reproductions of photographs. It brings out very vividly the extraordinary diversity of products obtainable from the Indian forests and should prove of value not only to the class of reader for which it is specially written but also to others interested in timber and the many other products dealt with.

GAS PRODUCERS FOR MOTOR VEHICLES AND THEIR OPERATION WITH FOREST FUELS. By I. Kissin. Imperial Agricultural Bureaux, Imperial Forestry Bureau, Technical Communication No. 1. Pp. 37, 9¾ × 7¼. (Published by the Imperial Forestry Bureau, Oxford; obtainable from the Central Sales Branch, Imperial Agricultural Bureaux, Agricultural Research Building, Penglais, Aberystwyth, Great Britain, 1942.) Price 3*s*.

The possibility of using producer gas for motor vehicles in place of liquid fuels is a matter of great importance even in normal times in places where petrol and heavy oils are costly. In present circumstances, when there is a serious shortage of liquid fuels in so many countries, the use of producer gas becomes even more important. The author of this publication has, therefore, performed a most useful service in reviewing recent data on portable gas producers and their use. In compiling the account the special needs of foresters in the British Empire have been kept in mind. For this reason the conversion of Diesel vehicles to producer gas operation, which is rarely undertaken in the British Empire, is not dealt with.

In the main the various technical problems involved receive chief consideration, but economic questions are also discussed. After a section on the theory of producer gas, the various types of generator are described (with the aid of diagrams), as well as the cleaning and cooling apparatus, the mixing valve and the controls. Then follow sections on layout, weight and cost of producers, loss of power, specially designed vehicles and performance ; the driving and maintenance of producer-gas vehicles ; charcoal fuel for gas producers and operating costs with charcoal gas. The final section discusses some of the wider aspects of the use of portable producers, including the extent to which they are used, the facilities for research on the subject, the organisation of the supply of producers and of fuel supplies, and the various measures employed or proposed to encourage the use of producers.

Although the treatment of such a wide subject is necessarily brief, the reader is provided with a list of some 75 references to which he can go for further information.

YOUTH IN MUSEUMS. By Eleanor M. Moore. Pp. ix + 115, 10 × 6¾. (Philadelphia: University of Pennsylvania Press; London: Humphrey Milford, Oxford University Press, 1941.) Price 12*s*.

" Youth as the life-blood of museums is a comparatively recent realisation," states Miss Moore in the opening chapter of this book, which describes what museums in the United States of America are doing for the youth of the country and, equally important, what youth by its interest and appreciation is doing for the museums.

Probably in no country in the world is youth served on such a lavish scale as in the United States where large grants are being expended to determine how museums may best be made of service to youth. It is said to be difficult to estimate the number of Children's Museums in the States as " they are springing up everywhere almost overnight like mushrooms," but many make a false start due to lack of knowledge of what is required of them and soon close down, whilst those which are successful flourish exceedingly. They differ widely amongst themselves and there is no set formula for their existence, hence the difficulty in finding a precise definition for them, the very name Children's Museum being open to question. Perhaps the best of the tentative definitions are " a wonderland for the child " whose " boundaries are marked not by age but by interest," and " a place where education is recreation and recreation is education."

To collect information for her book Miss Moore visited over 100 museums in the United States of America and several in Canada, and her observations embrace the various types of building used as museums ; the location, good and bad ; the staff—" the type of person who is most successful in museum work with children is reported everywhere as hard to find "—and the collections and typical exhibits, the latter including not only those coming within the categories of art, science, history and industry, but also hobbies (coin and stamp collections, etc.), seasonal exhibits and examples of children's work. The need for constant change of exhibits is recognised and the assistance of the community in making loans is commended.

The "docent," as the guide lecturer is called, plays an important part in successful children's museums, and correspondingly high qualifications are demanded of those who fill this post. He, or she, is required to be not only a specialist in the particular subjects to which the museum is devoted but also a trained teacher able on occasion to forget his learning and become the companion of a child who has an hour's leisure on his hands. Choice exhibits and a superior programme are said to fall flat in the hands of a weak or timid personality.

Discussing methods of display, a Director of one of the successful museums is quoted with approval as stating "Museums are in the show business the same as departmental stores and must 'sell' their collections to the public or lose out." The need for a high standard in the exhibits and in their presentation is stressed, it being considered false economy to neglect, even to a small degree, the constant care and cleanliness which are the finishing touches to successful exhibiting. But the successful museum "is not necessarily one that has arrived at its destination by the shortest, most efficient route—it is frequently not the one that has the widest variety of activities or attracts the greatest numbers, but the one through whose eyes children have experienced the most benefits."

Much useful information is given in chapters under headings "Supplementary Activities" and "Independent Activities," which treat of the part played by the child in the museums created for his benefit, and of how he is to be encouraged to make use of museums, and how his interest in them is to be stimulated and maintained.

The need for making exhibits both attractive to the eye and entertaining to the child mind has long been recognised at the Imperial Institute where, in normal times, children constitute a very high percentage of the visitors to our Exhibition Galleries; and many of the Empire Courts contain exhibits on the lines of those described in Miss Moore's book. For example, there are over one hundred colourful dioramas that can be illuminated by "switching on"; small scale models of Indian handicraftsmen, local irrigation methods and cultural operations and domestic animals; life-like sprays of economic plants and tropical fruits; press-button information machines and stillograph machines for the display of illuminated photographs; "switch on" coloured transparencies; attractively coloured relief maps; and story exhibits that trace the successive stages in the fabrication of articles of every-day use from raw materials of Empire origin to the finished product. The story exhibits are arranged under catchy captions such as "How many socks does a sheep wear?"; "The story of a shirt"; "From coffee cherry to coffee cup"; "From sheep's back to sale-room—the story of Indian carpets," etc. Amongst "Supplementary Activities" may be mentioned the film library and lantern slide library for the free issue of cinema films and lantern slides; the school specimens and publications service for the issue of specimens of raw materials for use in school museums; photographic picture cards of Empire industries and scenery; and picture posters based on the story exhibits in the Galleries with descriptive leaflets for teachers' use. Colour, which Miss Moore points out, plays such an important role in modern life is given to the various courts by silk banners and wooden shields bearing the Arms of the Dominions, the Colonies and India and Burma, and by the use of pleasing but subdued colours for walls and showcase backgrounds.

Miss Moore's book is welcomed as confirming some of the conclusions already arrived at and put into practice at the Imperial Institute; also for the many stimulating suggestions, and the optimistic outlook so much needed at the present time. It is sure of a warm welcome from all interested in Museum work whether on behalf of children or adults—for adults are children in their approach to subjects that fall outside the scope of their every-day experiences. By recording what has been successfully accomplished by museums in the United States Miss Moore draws attention to promising methods and procedure whereby children are enabled to find joy in the common things of life through the help of the children's museums.

MINERAL RESOURCES

ARTICLE

THE SERVICES OF THE IMPERIAL INSTITUTE TO THE MINING INDUSTRY[1]

By Sir Harry Lindsay, K.C.I.E., C.B.E.,
Director of the Imperial Institute

Fourteen years ago Sir Richard Redmayne, then Chairman of the Imperial Institute Advisory Council on Minerals, presented to the Institution of Mining and Metallurgy an able and comprehensive synopsis of the work and objects of the Mineral Resources Department of the Institute. Much has happened since then, and the ever-increasing demands now being made on the mining industry through the incidence of war naturally have their repercussions, though perhaps of a minor and subsidiary character, on an Institute whose primary function is to promote the development of the commercial and industrial resources of the Empire. The present time may therefore not be inopportune for a re-statement and re-emphasis of the many and varied ways in which the Imperial Institute strives to render practical assistance to an industry which is of such vital importance in both peace and war.

The revenues necessary for the maintenance of the Institute are provided, firstly from the income from the endowment fund; secondly from grants made to the Institute by the Governments of the United Kingdom, the Dominions, India, Burma, the Colonies and the Protectorates and Mandated Territories; thirdly from fees and rentals. The total income and expenditure balance annually at about £48,000, the bulk of which is contributed by Empire Governments. Indeed, there is scarcely a single Government of the Empire which does not contribute to the annual support of the Institute.

Organization of the Work of the Institute

It will be seen from the eight points of the Imperial Institute Act which constitutes our Charter (*Bull. Imp. Inst.*, 1938, **36**, 1-2) that these entail wide responsibilities and that they relate to raw materials of all kinds—minerals and metals as well as plant and animal products. In order to carry out these duties, the Institute is divided for technical and executive purposes into five main Departments, namely: (1) Mineral Resources Department; (2) Plant and Animal Products Department; (3) Exhibition Galleries; (4) Educational and Administrative Department; and (5) Accounts and Establishment. Each Department, as far as practicable, works in close co-operation with the others in order to avoid the equally undesirable extremes of overlap and isolation. There is a Statistical Division serving all Departments. The Library also serves each Department, although, for the sake of convenience, the literature dealing with mineral resources is kept separate from that of the general library. In normal times the staff of the Institute consists of about 150 members, of whom forty are fully-qualified scientists, many of whom have had experience overseas. They include economic geologists and mining engineers, mineralogists, chemists, assayers, chemical technologists, economic botanists and tropical agriculturists. When desirable, the Institute seeks the advice of any of its fifteen Consultative Committees which comprise authoritative professional and business men. Further help is afforded by the various Departments of State, by H.M. Commercial Counsellors and Trade Commissioners in various parts of the world, by Corresponding Members in certain parts of the Empire, and finally by the many trade contacts which we enjoy.

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[1] A paper submitted for discussion at a meeting of the Institution of Mining and Metallurgy held on 19th February, 1942. The paper and discussions which followed were printed in *Bull. Instn. Min. Metall.*, 1942, Nos. 449-451. This abbreviated text is reprinted by courtesy of the Editor.

MINERAL RESOURCES DEPARTMENT

From the point of view of the mining industry, the Mineral Resources Department is naturally the most important branch of the Institute. This Department consists essentially of two main sections—an Intelligence Section and a Laboratory Section—with ancillary services. The services which are available to members of the mining profession, and indeed to all British subjects who are interested, may perhaps be best summarised and illustrated under five main categories, namely:

(1) Technical and Commercial Intelligence Service,
(2) Publications,
(3) Statistical Service,
(4) Laboratory Investigation Service,
(5) Mining Law Service.

I propose to consider each of these services in turn and somewhat in detail in order to emphasize the comprehensive nature of the work we carry out, and the facilities which are generally available to the public, for I feel sure that despite the fifty years of its existence, the Institute is not nearly so well known as it should be. But before I proceed on my main theme, I should like to say a few more words about our Advisory Council on Minerals and the Consultative Committees.

We have, as I have previously indicated, fifteen Consultative

Committees at the Institute. Of these, seven are devoted to mineral and metal problems, and deal specifically with: (1) Base Metals (Chairman: Wm. Cullen, LL.D., M.Inst.M.M., M.I.Chem.E.); (2) Iron and Ferro-Alloy Metals (Chairman: Herbert K. Scott, J.P., M.Inst.M.M.); (3) Coal and Petroleum (Chairman: K. Neville Moss, O.B.E., M.Sc., M.Inst.C.E., M.I.Min.E., F.G.S.); (4) Precious Metals (Chairman: J. G. Lawn, C B.E., D Sc., A.R.C.S., M.Inst.M.M.); (5) Chemical Industries (Chairman: A. E. Dunstan, D.Sc., F.I.C., F.Inst.Pet.); (6) Miscellaneous Minerals (Chairman: G. H. Tipper, M.A., M.Inst.M.M., F.G.S.); (7) Mining Law (Chairman: W. Forster Brown, C.B.E., M.Inst.C.E., M.Inst.M.M., F.S.I.). The personnel of these seven Committees comprises Government representatives, geologists, mining engineers and trade experts. These Committees report their findings through their Chairmen to an Advisory Council on Minerals, which sits under the Chairmanship of Sir William Larke, K.B.E. Of the Council and Committees, twenty-four members are also members of the Institution of Mining and Metallurgy. I take this opportunity to express, on behalf of my scientific staff and myself, our very great appreciation of the assistance rendered to us by the members, both official and non-official, of our Advisory Councils and Consultative Committees. Including both the Councils (dealing with Mineral Resources and with Plant and Animal Products respectively) and the fifteen Consultative Committees of which, as I have mentioned, seven deal with Mineral Resources, the total membership is nearly 300. Their advice and assistance are of the greatest value to us; and although under war conditions the Councils and Committees are not asked to meet, we can always count on the informal assistance of any member, or group of members, whose advice is desired towards the solution of our day-to-day problems.

TECHNICAL AND COMMERCIAL INTELLIGENCE SERVICE

The Intelligence Section of the Mineral Resources Department is responsible for the collection and dissemination of technical and commercial information concerning mineral deposits in all parts of the world, and particularly those of the Empire. It supplies information not only to Government Departments but also to mining firms, trading companies and consumers both in the United Kingdom and overseas. Normally no charge is made for this service, but in special cases where firms or private individuals require detailed market and statistical surveys or comprehensive technical statements a fee may be charged. All work for Home and Overseas Government Departments, however, is carried out free.

Published information relating to new occurrences of minerals of economic importance and new developments in their exploitation and industrial utilisation is, of course, collected, indexed and arranged on a systematic plan. The same course is adopted with regard to information periodically received from Departments of

Mines and other Government Departments at home and overseas as well as from correspondents throughout the Empire. The Institute receives not only the publications of Dominion, Indian and Colonial Government Departments concerned with minerals and metals, but also similar publications issued by foreign Governments and by various scientific and technical societies, together with most of the technical and trade journals concerned with the mineral industry throughout the world. All these are carefully indexed and the whole of the information thus obtained is available for dealing with inquiries. But the Intelligence service goes much further, for at the Institute a technical inquirer has at his disposal in addition to this published information the services of an experienced and practical scientific staff to guide and assist him in attacking his problem. The inquiries and problems with which we are called upon to deal cover a very wide range of subjects, from the nature and occurrence of a given raw material to the manifold problems relating to its marketing and uses. Whilst, of course, it is easy to ask questions but not so easy to answer them, I think I can justly say that there are few reasonable questions on almost any aspect of the mineral industry which cannot be adequately tackled by the officers concerned, with the assistance, if necessary, of the distinguished personnel of our Consultative Committees, or of the numerous trade contacts which we enjoy.

Thus, for instance, in the earliest stages of a mining venture, prospectors and newly-formed mining companies frequently approach us with reference to those parts of the Empire in which a specific mineral is most likely to occur in economic quantities. A summary of all the relevant published data is at once provided, and this is often supplemented by observations regarding the nature of the deposit, the climate and topography of the country, and means of communication. Introductions may be arranged with Government officials of appropriate geological and mining departments, and the inquirer may thus be spared much time and money in the initial stages of his enterprise. In not a few cases we have advised him to proceed with the utmost caution, or not to proceed at all, as the evidence available demonstrated clearly that the prosecution of the project would be highly speculative and might be simply disastrous.

Another way in which we can and do assist the prospector or mill-manager is by examining and specifically determining his rocks, minerals and ore-products. Even in these days of enlightenment it is not always an easy matter for a prospector or geologist to be sure of his mineral diagnoses, working as he so frequently does in out-of-the-way places and with the minimum of scientific instruments and chemical reagents. We are to-day better equipped than ever before for this purpose, and plans are on foot to make this service even more effective than it has been in the past. During recent years we have identified all types of metallic and non-metallic mineral specimens, including not only the more common minerals but those like euxenite, samarskite, gold tellurides, gorceixite, schungite, jarosite, szaibelyite and variscite.

Occasionally we have detected instances of " salting " a mineral prospect, one well-known method being the injection of gold chloride into a mineral sample for assay. Although, of course, such procedure is to be strongly deprecated, the mineralogists and chemists at the Institute take a particular delight in unearthing such frauds. I am glad to record, however, that most of the frauds connected with minerals which have so far been discovered by the Institute relate to industries other than the mining industry. I am sure that my readers will agree with me that in this industry, *par excellence*, it is important to develop and maintain a quick intuition regarding the weak links in any chain of reasoning with which one may be confronted.

To the mill-manager and mining engineer much useful information may be afforded from the indexed records and books of our library, which is open to the public. This library contains some 75,000 works of reference, and is undoubtedly one of the best extant devoted to the raw materials of the Empire.

A further service is available for examining, identifying, assaying, and commenting on mineral products, in which the combined efforts of the Intelligence and Laboratory Staffs are brought to bear. Thus, for example: a small specimen was submitted for the determination of what was described as a " sulphide mineral." A polished section was accordingly made, and with the aid of the polarising ore-microscope and micro-chemical analysis, it was shown that the so-called " sulphide mineral " was heterogeneous, and made up of minute granules or crystals of galena, pyrite, chalcopyrite with some chalcocite, blende (sometimes containing finely-divided chalcopyrite) and a grey copper ore, probably tetrahedrite. The importance of such information in mill-dressing practice needs, of course, no emphasis from me.

There was another case in which information was sought regarding the nature of the actual mineral or minerals with which gold was associated in a finely-divided complex flotation concentrate. A suitable technique was evolved for the solution of this problem, comprising *inter alia* the separation of the individual minerals by means of heavy liquids and melts, their inspection under the binocular microscope for apparent homogeneity, and their examination by micro-chemical methods for gold. A polished section of the material embedded in dental cement was also examined. It was found that the gold was associated with both iron pyrites and arsenopyrite.

Numerous examples of such investigations could be cited, and although not all of them can be brought to a successful conclusion, the geologist and mining engineer will appreciate the following as being of interest. In a well-known gold producing region great difficulty was experienced in differentiating between the hanging- and foot-wall rocks of a banket reef, particularly in places where the reef was not visible. The information was required not only for mining purposes, but also to enable the geologist to work out the complicated folding and faulting of the district. A number of rock specimens taken at various distances on both sides of the reef were forwarded to us with the request that an attempt be made to establish scientific criteria of distinction between specimens from the foot-wall and hanging-wall. After macroscopic examination, density determinations were made, many thin sections were cut and examined, electromagnetic and " sink and float " separations were effected, and the nature and quantity (i.e. the index figure) of the heavy minerals were ascertained. It became evident, as a result of these tests, that the same quartzitic rock was present on both sides of the reef, and apart from such slight differences as were visible to the naked eye, no other distinguishing features could be established. Indeed, the old rough and ready method of the experienced miner who tried to distinguish the foot-wall from the hanging-wall by the way in which his hammer rebounded and the sound which was caused when the rock was struck, should have given as good results as any !

We try, of course, to be of assistance to the mining industry, not only in its initial and intermediate stages, but also in its final stages ; that is to say, taking a broad view of things, in the metallurgical and marketing fields. We are often called upon to prepare statements concerning the various and most appropriate methods of metal production, such as, for instance, the reduction of metals from complex or unusual ores and the extraction of economic materials from flue dusts and other waste products. In such cases the experience of the members of our Consultative Committees is of exceptional value to us, and we are indeed fortunate in being able to make full use of their expert advice.

With regard to the marketing of raw materials and semi-manufactured products of all types, I think I can claim that we have gained the confidence of all the more important brokers and consumers in this country. This we value highly, and the trade reports which are furnished to us by such firms on material which our preliminary examination has shown to be worthy of their attention cannot, I am sure, be over-estimated.

The way in which the Institute assists the mining industry by investigating additional or entirely new markets for the products of the industry is well illustrated by our work in connection with Sierra Leone " micaceous " haematite. Sierra Leone iron ore is marketed principally as lump ore, but part of the production is in the form of " micaceous " concentrates which must be briquetted or sintered before they can be smelted. Formerly these concentrates were exported almost entirely to Germany and, in the early stages of the war, Great Britain was unable to utilise all the concentrates produced, as sintering capacity here was fully employed. Certain types of micaceous haematite have special uses in the manufacture of anti-corrosive paints and especially on the Continent for coatings for arc-welding rods, and samples were therefore submitted by us to British manufacturers of these products. Although the flakes were found to be too thick for use in paints, the electrode manufacturers after preliminary trials found the material to be suitable for their purpose, one firm requesting larger amounts for extended trials. These proved successful, and the concentrates, which of course command a higher price than they would as an iron ore, are now being used in this country in arc-welding rod manufacture, although the market is naturally much smaller. This development is particularly opportune at the present time since it has provided an Empire substitute for Swedish magnetite formerly used for welding rod coatings, but now no longer available to us.

In many instances we have had a hand in the initiation of new industries in Empire countries. Nearly ten years ago, for example, a mining engineer in Malaya enlisted our aid in finding a market for the large quantities of ilmenite available in that part of the world. We examined samples for him and advised him regarding magnetic concentration and the requirements of the market. Subsequently, we examined his magnetic concentrates which were very promising, endeavoured to interest British manufacturers of titanium pigments in them, and put him into touch with a number of firms both in this country and abroad. And we did not let the matter rest until he told us that he had been successful through our aid in marketing 2,000 tons of ilmenite, thus initiating the ilmenite industry of Malaya. More recently, again, we found in a bag of mixed mineral specimens sent us by a correspondent in Kenya, a most promising piece of magnesite. In due course, after we had supplied the owner of the deposit with information about the marketing and uses of this mineral and about plant for calcination, the deposit was opened up. Magnesite from this source helped to supply our urgent needs of this mineral recently when it became impossible to get any more from Greece.

Our Intelligence section does not rest content with the work of disseminating information by means of mineral monographs, the mineral section of our Bulletin, and answering inquiries, but when opportunity occurs it initiates search in the Empire for minerals for which it has observed a demand is arising or is being met by material from foreign sources. Recent examples of such work include a search for additional supplies of micaceous haematite, piezo-electric quartz, flake graphite, emery and vermiculite. In the latter case it was evident that an increasing demand for this mineral was arising for heat and sound insulation, but supplies were coming solely from outside the Empire. The matter was brought to the notice of various Empire mining and geological officers and as a result, supplies of suitable material have been located in the Union of South Africa, Australia and Tanganyika, and samples have been sent to the Institute for examination and report. Vermiculite from South Africa is now taking its place in the market and Australian material has also been sold locally.

A few months ago the Research Association of British Rubber Manufacturers enlisted our aid in finding a substitute for a material known as asbestine obtained from abroad for use in the rubber and paint trades. One of my staff conceived the idea that a certain type of asbestos which occurs in South Africa, if suitably prepared, might serve the same purpose. Samples obtained through the South African authorities in London were prepared in suitable form at the Institute and have been tested by the rubber and paint trades with most promising results.

Thus, in all phases of the mining industry, we try in our modest way to be of some assistance; sometimes we are successful, sometimes not so successful, but still we try. We are never tired of trying, whatever the result.

PUBLICATIONS

In pursuance of its policy of collecting and disseminating information, the Institute issued its first monograph on mineral resources in 1919. Others rapidly followed and, by 1925, some twenty monographs each dealing with a separate mineral or metal had been published. In that year, the Imperial Mineral Resources Bureau was amalgamated with the Institute, and a joint publication policy was adopted, with the result that at the present time over fifty monographs are available to the mining industry. Unfortunately a number of these are now out of print, but they can, nevertheless, still be consulted at the Institute's library. In recent years we have aimed at a quinquennial revision of each monograph, but this, I regret, has not materialised owing to shortage of staff, the ever-increasing volume of mineral inquiries, and the critical times in which we live. Despite these factors, however, we have since 1936 published monographs on Asbestos (1937), Barium Minerals (2nd Ed., 1937), Chrome Ore and Chromium (2nd Ed., 1940), Magnesium, Magnesite and Dolomite (1939), Manganese (1938 and 1941), Platinum and Allied Metals (2nd Ed., 1936), and Strontium Minerals (2nd Ed., 1937). In addition, we have issued a comprehensive work on "Mining Royalties and Rents in the British Empire" (1936), and a general treatise on "The Mineral Position of the British Empire" (1937).

As far as practicable, all the monographs conform to a set format which includes (1) a general introductory statement to the mineral or metal under consideration; (2) a description of its natural occurrence and world distribution; (3) methods of exploitation and preparation for the market; (4) properties of the material; (5) industrial uses of all types; (6) marketing and prices; (7)

world's production; (8) details of the resources of the material in all producing countries, and in others where economic deposits are believed to exist; and finally (9) a selected and classified bibliography of the technical literature relevant to the subject. Before publication the sections dealing with Empire occurrences are submitted, when necessary, to the appropriate Geological Surveys or Mines Department to ensure that the information is up to date and the whole document is finally approved by one or other of our Consultative Committees on Minerals. It is believed that these monographs provide one of the best means of disseminating information; consequently they are freely distributed to Empire Government departments and are sold to the public at prices sufficient only to cover the cost of printing.

About one-third of each issue of our quarterly Bulletin deals with current mineral topics, reports of investigations of general interest carried out in our laboratories, articles, and notes, and a fairly comprehensive selected and classified bibliography of the more important reports, articles, etc., which have been received at the Institute during the preceding three months. We have reason to believe that the last-mentioned feature is much appreciated by geological and mining officers in the Colonies whose opportunities of perusing technical literature are often very limited. The Bulletin bibliography serves as a useful supplement to that provided in our monographs, although actually it covers a far wider range of subjects than we have, as yet, been able to deal with in that series of publications. The articles are contributed not only by members of our own staff but also by expert officers overseas.

Perhaps the most widely known of our publications is the annual Statistical Summary, to which I will refer in more detail under our Statistical Service.

In addition to our official publications, I should also like to refer to two lectures given to technical societies during the past year by Mr. S. J. Johnstone, B.Sc., F.I.C., Principal of our Mineral Resources Department. In the first of these, entitled "Empire Mineral Resources and their Relation to the War Effort," published by the Institute of Chemistry in March 1941, as the Twenty-third Streatfeild Memorial Lecture, the author gave a résumé of the Empire's position and production of most industrial minerals and metals, with their chief uses and particulars of the outputs from the more important producing localities.

The second contribution, on "Minerals for the Paint Industry," was delivered to the London Section of the Oil and Colour Chemists' Association and published in their Journal (1941, 24, pp. 263-287). It gave a description of the uses of the numerous minerals employed in paint and pigment manufacture, the grades of material acceptable to the trade, and an account of sources of supply now being worked, either in the United Kingdom, or, when home supplies are not available, in the overseas Empire. Judging by inquiries since received at the Institute, this publication appears to have been of considerable interest to the industry concerned.

STATISTICAL SERVICE

The provision of carefully digested statistics of production, imports and exports of minerals and metals is a service undertaken by the Institute which in normal times issues an annual volume of about 450 pages entitled "Statistical Summary of the Mineral Industry of the British Empire and Foreign Countries." This annual volume is accepted as authoritative by Home and Overseas Governments and is widely quoted. Indeed, the United States Bureau of Mines has said of it, "For statistical research purposes, this annual volume represents a contribution that is not paralleled by any similar publication of other foreign government agencies."

Statistics which merely record the amount of mineral produced without stating its tenor are often of but little value to the mining man or economist who wishes to get an idea of the amount of recoverable metal or oxide produced, the terms "ore" or "concentrate" often having but little significance. For this reason we have always endeavoured to give such information, whenever possible, in our various publications on minerals.

Normally the publication of our Statistical Summary for any given year is not possible until well on into the following year, owing to the fact that many official returns are not received until possibly seven or eight months after the conclusion of the year, but the preparation of the volume goes on all through the year so that all available data are accessible to our inquirers. We also have arrangements to supply some firms with detailed monthly statistics regarding certain products. Needless to say our Statistical Section has proved to be of inestimable value to numerous war-time Government Departments.

A year or so before the war it became evident to us that current statistics of production of minerals from the Colonial Empire, as distinct from the Dominions, were often not readily available in this country. We therefore arranged for the Mines Department of each country to send us quarterly statistics of their production, and these were published in our Bulletin, under the title of "Progress in Colonial Mineral Industry." Most of the Colonies co-operated wholeheartedly in this matter and we have reason to believe from inquiries received that we provided a useful service. Unfortunately war conditions have necessitated the suspension of this service, but we hope to resume it as soon as we can. Possibly when it is revived it might usefully be extended to include not only statistics of production but also those of export by countries of destination.

The desirability of a unified system for recording mining and metallurgical statistics is, I am sure, quite evident to members of the Institution of Mining and Metallurgy. The late Imperial

Mineral Resources Bureau devoted considerable attention to this subject and drew up a comprehensive set of forms for this purpose. This work was continued by the Imperial Institute and, although the project was laid before the Committee of Statistical Experts of the League of Nations and correspondence ensued over a number of years, no definite action resulted.

Later the possibility of formulating an Empire Scheme was discussed at the Conference of British Commonwealth Statisticians held in Ottawa in 1935. The Conference by resolution strongly supported the efforts made by the Imperial Institute to promote the unification of mining and metallurgical statistics within the British Commonwealth. In view, however, of the complex character of many of the non-ferrous ores produced and the difficulty of classifying such ores within the framework proposed, the Conference recommended that a further study should be made by the Imperial Institute as to the method to be adopted for recording production of such ores. It was suggested that the questions at issue could be best dealt with by personal discussion between representatives of the Imperial Institute and the various authorities concerned with such statistics throughout the British Commonwealth. So far, however, it has not been possible to implement the resolutions of the Conference.

To be concluded.

ABSTRACTS AND NOTES

Shetland Chrome Ore.—The recent use of chrome ore from the island of Unst in the Shetlands in the manufacture of refractory bricks was referred to briefly in the Imperial Institute monograph on *Chrome Ore and Chromium*, 1940. A comprehensive study of this ore and of its applications in refractory compositions by T. R. Lynam, J. H. Chesters, T. W. Howie and A. H. Jay, which has lately appeared in *Trans. Ceramic Soc.* 1942, **41**, 27-45, describes the joint researches of the Oughtibridge Silica Firebrick Company Ltd., and the United Steel Companies Ltd., in the development of chrome-magnesite bricks from this ore, and gives details regarding manufacturing methods and the behaviour of the bricks in service.

The ore employed in the researches came from a quarry at Midgarth, which was reopened three years ago and has since produced about 1,000 tons of high-silica chrome ore consisting of an intimate mixture of chromite grains and serpentine gangue. The proportions of these constituents vary from lump to lump but normally from 25 to 50 per cent. of the material is serpentine gangue. The following range of analysis of the Shetland ore may be considered typical: SiO_2, 10-20; Al_2O_3, 5-12; Fe_2O_3, 12-18; MgO, 20-30; Cr_2O_3, 25-45; CaO, 0-2 per cent., so that the silica content is very high in comparison with that of chrome ore normally employed for refractory purposes (about 5 per cent.). In a refractoriness-under-load test, using a load of 28 lb. per sq. in., the test piece began to subside at 900° C., and the fail temperature was 1,460° C.

Since so large a proportion of serpentine gangue is present a special study was made of this alone. Its optical properties were similar to those of antigorite and chemical analysis showed: SiO_2, 33·2; Al_2O_3, 2·5; FeO, 6·9; MgO, 37·6; Cr_2O_3, 4·4; loss on ignition, 15·2 per cent. Cones cut from the serpentine had a melting point of about 1,740° C. In a refractoriness-under-load test the gangue material failed at 1,520° C., and tests made to determine the effects of the introduction of impurities on the refractoriness-under-load gave interesting results which are tabulated in the paper and discussed in some detail. The addition of magnesia, as expected, increased the refractoriness owing to the conversion of the serpentine into forsterite; substitution of part of this by lime resulted in a drop in the fail point whereas substitution by ferrous oxide had the opposite effect. Replacement of part of the magnesia in an 80/20 serpentine-magnesia batch by alumina resulted in a progressive decrease in refractoriness, and when titania was substituted for magnesia the drop was very much more marked and rapid. For example, whereas with 20 per cent. of added magnesia the test piece showed 10 per cent. deformation at 1,620° C., with 19 per cent. magnesia and 1 per cent. titania the shear failure point was reached at 1,390° C.

In the manufacture of chrome-magnesite bricks from Shetland chromite about 60 to 70 per cent. of coarsely crushed chrome ore ($\frac{3}{16}$ in. to 25 mesh) is mixed with 40 to 30 per cent. of finely ground dead-burned magnesite (mostly passing 72 mesh), moistened with 5 per cent. of water, and moulded in a hydraulic press under a load of 15,000 lb. per sq. in. The bricks, having been dried in a tunnel drier at about 60° C., are fired at about 1,400° C. in down-draught kilns of the beehive type. Firing at higher temperatures does not improve the bricks. The characteristics of the product are tabulated in the paper, and the results compare very well with those obtained on a chrome-magnesite brick made from Grecian chrome ore. One of the main features is the low bursting tendency when in contact with mill scale. In refractoriness-under-load tests at maintained temperatures chrome-magnesite bricks made from Shetland ore showed 0·9 per cent. subsidence after 1 hour at 1,400° C., 2·5 per cent. after 1 hour at 1,500° C., and 6·7 per cent. after 1 hour at 1,600° C.

After many works trials these bricks have proved to be very satisfactory in the front walls, side walls and ports of open-hearth furnaces and in arc-furnace linings and their use is now considered standard practice in these positions.

It is satisfactory to note that these bricks are manufactured entirely from raw materials produced in the United Kingdom.

Tungsten Ores in Namaqualand and the Orange River Area.—The principal tungsten deposits in the Union of South Africa occur in the north-west corner of the Cape Province. In this district, which extends for a distance of 250 miles from the Steinkopf native reserve along the course of the Orange River to Upington, numerous deposits of both scheelite and wolframite have been discovered within the last ten years, and between 1938 and 1940 small-scale workings yielded a steady output of nearly 100 tons of concentrates annually. The Geological Survey of the Union of South Africa described the geology and mineralisation of a part of this area in some detail in 1937 in Memoir No. 31, " The Pegmatite Area South of the Orange River in Namaqualand " and has now published a special Bulletin (No. 13), " Tungsten Ores in South Africa with special reference to Namaqualand and the Orange River " by G. K. Joubert, with a view to stimulating the exploitation of these deposits.

Geologically, the country along the Orange River consists of granitic intrusions of the basement granite series into older rocks, both sedimentary and volcanic and others whose original nature has been obscured by metamorphism. The intrusion of one of the youngest granites was followed closely by numerous pegmatites accompanied by the deposition of economic minerals, apparently under high temperature conditions. The numerous inclusions of older rocks, now appearing as elongated schistose bands in the granite, have formed the main channels within which pegmatitisation and mineralisation took place. In other cases the mineralisation is found in shear zones, now filled with biotite schist, cutting through older crystalline rocks. Garnetised and epidotised hybrid rocks which retain vestiges of stratification are favourite repositories of tungsten ores, which occur in numerous thin parallel quartz veins associated with pegmatite lenticles. The gangue of the tungsten veins is usually quartz with very little other pegmatite base, and where the ore appears to be in normal pegmatite, or even in granite, an obscured quartz vein must be suspected. The very numerous pegmatites carry a variety of economic minerals but are not normally favoured by tungsten minerals. Minor quantities of fluorspar and molybdenite may be found within tungsten veins.

Along the strike of an ore zone the productive parts are usually lenses and pockets. Some veins may bulge or pinch out on a single continuous fracture plane, while others become scattered as numerous thin lenticles within a limited width of country rock. In garnetised schist zones the prospector will rather follow the thin lines indicating fracture planes than actual quartz, as here the ore tends to occur in lumps confined to the fracture plane. In its wider distribution the ore may be found in numerous small occurrences over the whole of a farm, or over a base-mineral claim. Hitherto such scattered deposits have usually been opened up only by numerous small workings on outcropping ore, with no attempt to follow ore shoots. Thus it is not yet known whether or not a number of these small workings could ultimately be joined up along the strike into continuous orebodies which would be payable on application of efficient methods of concentrating low-grade material. Several occurrences are already known to be of sufficient size individually to warrant small mining operations. The latest finds near O'okiep indicate the possibility of large-scale low-grade mining enterprise. Here the metamorphosed sedimentary rocks in the granite-gneiss carry impersistent ore veins throughout their entire widths and in sufficiently dense distribution, together with rich lumps of wolframite associated with quartz blows and recrystallised quartzite masses, to form workable ore.

Both wolframite and scheelite are found in the area, but they usually occur in separate districts. Scheelite appears to be the earlier, for, in the few localities where both occur, the wolframite may enclose a core of scheelite, and appears to have resulted from replacement of the latter by solutions rich in iron and manganese. Deleterious associates of tungsten ores are rarely found, and sellers have never been penalised for impurities such as arsenic, copper, phosphorus or tin. Copper may occur in some scheelite veins, and arsenical sulphides have been found, but tin is almost completely absent. It is difficult to establish the grade of the ore bodies as the distribution of ore within the veins is so erratic. In one case, to quote an extreme example, what appeared to have turned into a barren vein unexpectedly yielded a solid mass of pure scheelite weighing 2½ tons. Production to date shows yields of well over 1 per cent. tungstic oxide, but these represent hand-picked material from coarse pockets only and do not take account of the considerable losses of fines or of finely disseminated ores which cannot be dressed by these methods.

Until 1940 a large part of the production was scheelite from the Steinkopf native reserve. Natives worked the easily recoverable ore near the surface, and by handpicking, cobbing and washing obtained a concentrate containing about 40 per cent. tungstic oxide. This was sold to local storekeepers who dressed it at their stores and produced a marketable concentrate with 60 to 70 per cent. tungstic oxide. Prospectors, local traders and small syndicates also produced scheelite near Goodhouse and wolframite from farms in the neighbourhood of Dabaras in the Kenhardt district, and a small wolframite mine was developed at Collinskop north of the Orange River in Gordonia district. More recently the field of search has extended eastwards and southwards. New finds are being developed at Rhenosterkop, one of the Kakamas river settlements, and at Dyasonsklip, 14 miles west of Upington. Towards the south several new places are being opened up within the copper field round O'okiep, where despite the long history of mining in the area the plentiful tungsten ores have only just become known. It is highly probable that more surface occurrences of tungsten ores remain to be discovered both within the present boundaries of the field and beyond, for similar geological conditions appear to continue southwards for 60 miles to Garies and eastwards for 100 miles from Upington to Prieska.

Mining in New Caledonia.—An article of topical interest by H. E. L. Priday on "New Caledonia's Mineral Wealth" appeared in *Chem. Engng. Min. Rev.*, 1941, **33**, No. 396. The mineral wealth of the country constitutes 93 per cent. of its primary exports and includes important quantities of nickel, which amount to about 8 per cent. of the world's present requirements. Nickel ore was was first discovered in New Caledonia in 1865 by Jules Garnier, one of a group of French mining engineers who were investigating the mineral resources of the island. A sample shipment to Paris was found to contain about 12 per cent. nickel, and the Société le Nickel, which now operates the largest mines, was formed. In the early days only the green ore (named garnierite, after the discoverer) carrying 7 per cent. or more of metal was shipped, mainly to the United Kingdom and Belgium, and the chocolate ore (coloured by iron oxide), although often as rich as the green ore, was discarded. Latterly, abandoned mines have been reopened, and ore carrying as little as 3·5 per cent. nickel was being exported to Japan up to the end of 1940.

The ore is found in surface deposits at an altitude of 300 to 1,000 metres above sea-level and is worked by open-cut methods. It is transported in ½-ton skips by aerial ropeway working by gravity, and in this way two men can handle 100 tons a day. The largest producing centres are at Thio on the east coast and Voh and Koné on the west coast, all operated by the Société le Nickel, who possess smelters in Noumea. About twelve small mines which produce roughly a third of the island's output, are operated by individual owners. Some of their ore is bought by the Société le Nickel, and the balance was formerly exported to Japan and Germany, the latter importing ore containing 4·7 per cent. nickel to mix with her own low-grade ore. The cost of the Japanese, Tonkinese and Javanese labour is about 17·50 francs per man-day, of which the labourer is actually paid 81 francs per month, the balance being made up in food, housing, clothing, medical and other emoluments.

New Caledonia is also a leading world producer of chrome ore, most of which is exported to the United States.

The Tiebaghi mine is one of the largest and richest single deposits of chrome ore in the world, the ore consisting of crystalline chromite containing 56 per cent. Cr_2O_3. The ore-body has a known extent of 30 by 60 metres with a known depth of 400 metres. The American-owned Fantoche mine and the Australian Chagrin (working low-grade ore averaging 35 per cent. Cr_2O_3 which is subsequently concentrated) are the only other chrome mines working on the island, apart from two small enterprises washing beach sands, although many other deposits are held on mining leases.

Since foreign companies are not permitted to work deposits in New Caledonia the larger concerns, which are in fact controlled by foreign capital, are operated through dummy companies, the majority of whose directors must be French nationals. Government taxes are imposed on the gross value of ore sold for export based on estimated market prices, and are fixed quarterly in advance. The present tax is 2·5 to 9 per cent. according to grade of ore plus a special war tax, but a reduction of 25 per cent. is allowed to companies when ore has to be concentrated before shipment. Shipping difficulties are considerable as there are few wharves and lighterage is expensive.

The industrial utilisation of the iron ore deposits of the island has been neglected, but the deposits are of considerable extent and are, in fact, not only easy to exploit but are nearer to the port of Newcastle, New South Wales, than are either those of Iron Knob in South Australia or Yampi Sound in Western Australia. Exploitation of the iron ore commenced in 1939 when the Société le Fer, with Japanese capital, began to operate the Cascade mine on the plateau of Goro and loaded 91,500 tons of ore containing 50 to 52 per cent. iron on to Japanese ships. This probably increased to 300,000 tons in 1940. The company has installed wharves and plant capable of handling up to 500,000 tons a year, ships being loaded by endless chain at a rate of 700 tons in 15 hours.

The island contains one or two coal mines, but these have not been successful, and there appears to be a lack of good coal.

Copper mines on or near the Diahot river in the north of the island have been operated intermittently since 1874, but have never been continuously successful.

Cobalt deposits are associated with the nickel and chrome and were at one time extensively worked by many small operators. Traces only of these workings remain, but a few tons of ore were shipped to Japan in 1939.

Gold, manganese and antimony have been produced in the past and other metals known to occur in the island include molybdenum, mercury, silver-lead-zinc, and platinum. Gypsum is obtained at Pouembout on the west coast.

The Diamond Industry.—The over-running of the low countries and the increased industrial activity of both Great Britain and the United States has led to widespread changes in almost every aspect of the diamond industry which have brought in their train many difficult problems. In order to help to solve some of these difficulties in the United States, the Mineralogical Society of America recently convened a meeting of experts on diamonds, and the highly informative papers contributed by these authorities have now been published in *The American Mineralogist*, 1942, 27, (3), 162-191, under the title of "Symposium on Diamonds," from which the following very brief notes have been abstracted.

The changes referred to have not only been geographical from the point of view of the origin of supplies and geological from the standpoint of the age and mode of occurrence of the deposits now worked, but there have also been changes in mining methods and in the amount and nature of the diamonds produced, and in the uses to which they are put.

From about 800 to 600 B.C., until displaced by Brazil in the eighteenth century, diamonds came largely from India. In turn, Brazil gave place to South Africa towards the end of the nineteenth century, while from 1907 to 1930 the important alluvial fields of the Belgian Congo, South-west Africa, Angola, the Gold Coast and Sierra Leone, all rich and cheaply operated, have come into the forefront of production.

Present-day production is of the order of 14,000,000 carats, worth $35,000,000, compared with an average of 7,200,000 carats, worth $75,000,000 in each of the four years from 1927 to 1930. The decrease in the average value per carat is almost entirely due to the influx of boart from the Belgian Congo, where one company alone, Beceka, has been responsible for one half of the world's production of boart by weight. Attention is drawn to the fact that only about 16 per cent. of the world's production in 1940 was of cuttable grade, compared with 55 per cent. in 1927.

The leading producer of diamonds in the world to-day is the Belgian Congo, which accounts for 75 per cent. by weight and 25 per cent. by value, followed by Angola, Sierra Leone, the Gold Coast, Brazil and South Africa. Before the war the order was Belgian Congo, South Africa, Gold Coast, Angola, Sierra Leone. The British Empire now produces about 25 per cent. by weight and rather less than 50 per cent. by value of the total world output.

Whilst most of the output of 30 years ago came from kimberlite pipes of Cretaceous age, in 1940, 96 per cent. by weight and 72 per cent. by value of the production of the African continent was obtained from alluvial deposits derived from Pre-Cambrian rocks. Accompanying this change from pipe mining to alluvial washing, is of course, the change in recovery methods referred to above, and the industry is now characterised by a relatively large number of small plants compared with the few very large plants of 30 years ago.

The use of diamonds in industry has increased eightfold in the last 25 years, and is the principal factor in the diamond market of to-day. More than 75 per cent. by weight and 33 per cent. by value of the rough diamonds sold are industrial stones, the United States alone consuming about 3,000,000 carats in industry annually.

The increased sales of gem diamonds in the United States, Canada, South America, and the East, have been more than offset by the practical cessation of sales elsewhere. Nevertheless, industrial diamonds, with the exception of those from the Beceka company in the Congo and from Brazil, are by-products of gem-mining. The world's annual production of about 3 tons of diamonds requires the efforts of some 70,000 men, of whom 8,000 are Europeans, so that each man produces less than 1½ oz. of diamonds for a year's work ; considering gem diamonds alone, the production is less than ½ oz. per man per year. The average tenor of alluvial diamond mines of the world is about 1 part in 40,000,000.

Of the former world's supply of polished diamonds, 95 per cent were manufactured in the Low Countries and Germany ; 40,000 polishers were employed in Holland, Belgium and Germany, 1,000 in France, England and the Transvaal, and about 250 in the U.S.A. Before the war Germany was making strong efforts to expand its industry in custom polishing, and sometimes granted subsidies to enable the industry to reduce its labour costs.

Infiltration of diamonds into the U.S.A. by indirect routes and the stocks in the bonded warehouse made the diamond shortage in the U.S.A. at the time of the invasion of the low countries considerably less than was anticipated. Since that time the number of polishers in the United States has greatly increased, and there has also been a change to quantity production from the quality production of gem diamonds which formerly characterised the American industry.

Diamonds are extensively used in the high-speed drawing of wires from 0·08 in. diam. down to 0·0003 in., the finest made. Dies with openings between ·01 and ·001 in. are known as double nought dies, those with holes less than ·001 in. as triple nought, and the very finest as capillary dies. The production of these dies, which is accomplished by drilling from 130 to 200 hours with a steel needle charged with diamond dust, is a highly skilled operation requiring many years of experience to acquire under existing conditions. Some time ago, therefore, the Americans, with the aid of the British Controller of diamond dies, took steps to encourage domestic production so that a steady flow of such dies to industry, all of which were formerly imported, was not interrupted. The principal problems to be overcome were the selection of personnel, the grinding of the needles to the proper size and shape, selection of the right diamond powder for drilling, the method of mounting the stone, the amplitude and intensity of the reciprocating action of the part carrying the stone to be drilled, the speed of the needle, prevention of vibration and means of observing the progress of the drilling. Practically all these problems have been solved in a new die-drilling machine produced by the British die controller who sent a model machine together with drawings and pertinent data to the United States, where copies of the machine are being manufactured.

The use of diamonds in set tools and abrasive wheels provides important outlets for industrial stones. Shaped diamond tools are used not only to cut a pre-determined contour directly into various materials but also to cut the " negative " of a contour into a grinding wheel which will itself be used to reproduce the positive contour on the material. Bonded diamond wheels are made of crushing boart set in either synthetic resin or in metal and are used chiefly for shaping cemented carbide tools. In addition, however, these wheels are being used in shaping special porcelain insulators of sparking plugs, in slicing piezo-electric quartz, in grinding lenses and for other abrasive purposes.

The Industrial Utilisation of Gold.—The pre-eminent position of gold as a medium in international exchange and as the fiduciary backing to paper currency frequently obscures the fact that a not inconsiderable amount, estimated at between 5 and 10 per cent., of the world's annual production of the metal is regularly consumed in the useful arts. In ancient times, of course, gold was used almost exclusively for decorative purposes, and even to-day there tends to be a misconception that gold is less intrinsically useful than many other metals when in fact its use is only restricted by the limited supplies available, or, in other words, its relatively high price. In spite of this latter consideration, however, the amount and the number of ways in which gold is used in industry to-day are greater than ever before and the industrial uses have recently been reviewed by E. Downs in *Chemistry and Industry*, 1942, **61** (14), 156, under the title of " Gold and Its Scope in Industry."

The principal properties on which the usefulness of gold rests are its malleability and ductility, its decorative colour and resistance to corrosion, its high electrical-conductivity and reflective power, and the therapeutic effects of some of its salts. In the pure form, however, gold is too soft for most industrial uses and it is, therefore, alloyed with silver, copper, platinum or with other precious and base metals. There have also been developed a number of age-hardenable gold alloys which possess properties of strength and resistance to wear superior to those of normal gold alloys of the carat type. Typical groups of these alloys are the gold-platinum-copper-silver combinations, the gold-platinum alloys, and a further important group containing gold, palladium and silver with the addition of small amounts of cobalt, nickel, zinc, tin or copper.

Another useful property of gold is that its natural colour can be varied, white gold being produced by the addition either of nickel, zinc and copper, or of palladium and silver. Green, blue and purple alloys are obtained by the addition of cadmium, iron and aluminium respectively.

The earlier methods of producing gold-covered surfaces by mercurial or by immersion gilding are now little used, having given place to the methods of electrogilding or electroplating articles by making them the cathode in a bath of potassium auricyanide with gold as the anode. The thickness of the gold is controllable in this method, but for many purposes a thickness of ·00005 in. is satisfactory. Such plated gold possesses the properties of the solid metal in that it will take a high polish, has high electrical conductivity and freedom from tarnish. It finds application for example in sound-transmitting apparatus where plated electrodes receive the impulses set up in the carbon granules.

Gold-leaf is the most familiar form of surface covering with gold as in picture-frames, sign-writing, gilt labels in hats, shoes, book coverings and titles, edges of playing cards, etc. Gold-leaf can be applied to a variety of surfaces, including wood, paper, leather, metal, glass, plaster and stone, and as this product is only of the order of four millionths of an inch thick, 1 oz. of the metal will produce about 250 sq. ft. of leaf which at 168*s.* per troy oz. is equivalent to only $\frac{1}{18}$*d.* per sq. in.

A comparatively new method of surface coating of articles with gold is by the method known as cathode sputtering or cathode dispersion. In this method the articles are placed in a vacuum in the path of the gold particles discharged on passing a high current from a gold cathode to an aluminium anode.

Yet another method of depositing thin gold films on glass or metal is by heating gold electrically in a high vacuum and allowing the gold vapour to settle upon articles placed in the vacuum chamber. Glass covered in this way with a thin gold film is impervious to ultra-violet light but passes a certain amount of visible light of a green tint, and this property is utilised in the manufacture of special spectacles for people suffering from iritis.

Gold-covered silver wire as used in gold braid, embroidery, etc., is made by electroplating a bar about 2 in. diam. and then drawing down to the requisite gauge.

Rolled gold commonly employed in spectacle frames, watch cases, pencils and cheaper jewellery continues to be one of the most important forms of industrial utilisation of the metal. It is made by soldering or welding a plate of gold of any required caratage onto one or more sides of a base block about 6 in. square and from 1 to $\frac{1}{4}$ in. thick, after which the whole is rolled out to the required thickness. Such coatings, which are of a uniform thickness varying from ·1 to ·000002 in., bear a constant ratio to the thickness of the base block. Seamless gold-plated tubes and wires can also be produced in this way and the great merit of this process over electrodeposited gold is the hard, impervious wrought structure and greater resistance to wear.

In the ceramic industry "potter's liquid gold," a clear brown varnish consisting of a solution of complex organic compounds of gold in essential oils, etc., is brushed on pottery and afterwards fired. The standard liquid contains 12 per cent. fine gold, but cheaper ones containing as little as 7 per cent. are also made. Liquid burnish golds are also used in ceramic decoration and consist of a suspension of gold powder in liquid gold, silver being added to vary the colour. Gold is also added to liquid lustres in the production of lustre ware, whilst "Purple of Cassius" is used in stained glass, enamels, china, porcelain, etc.

Gold is used in dentistry both as fillings and in dentures and in orthodentic wires and use is sometimes made of platinum-gold and of palladium-gold alloys in dentistry.

In chemical plant and laboratories, the use of gold is naturally restricted by considerations of cost, but a high-gold palladium alloy with a melting point of 1370° C. can sometimes be used as a substitute for platinum when the price of this metal is very high. This alloy is said to be equally as resistant to mineral acids and caustic soda as platinum and very resistant to alkali, carbonate and bisulphate fusions. Gold-lined plant is used in the distillation of certain essential oils, for containing liquors concerned in the wet viscous process of artificial silk manufacture, and in gold-platinum alloys in spinnerets.

Gold as the pure metal and as an alloy with palladium is also used in thermocouples, as a fuse in electric furnaces, in electrical contacts, whilst amongst a veritable host of miscellaneous uses, mention may be made of the use of the metal and its alloys in the hair-springs of chronometers, in the suspension wires of galvanometers, in coating base-metal conductors carrying high-frequency radio-currents, in the plating of mirrors in infra-red drying apparatus, in electrical equipment for measuring the speeds of aircraft engines and in X-ray work and radium therapy. In recent years a number of gold salts have found application in the treatment of rheumatoid arthritis, in certain chronic skin diseases, and in tuberculosis.

Arsenic in Natural Phosphates and Phosphate Fertilisers.—An investigation carried out by the United States Department of Agriculture has shown that, although arsenic is present in greater or lesser quantities in all natural phosphates and in superphosphate, it is very unlikely that the quantities of arsenic contributed to the soil in phosphate fertilisers are sufficient to produce toxic effects on plants, even with a very large annual application of fertiliser over an extended period of time.

The results of the investigation are discussed by T. H. Tremearne and K. D. Jacob in *U.S. Dept. Agric. Tech. Bull. No.* 781, November 1941. The proportion of arsenic present in mineral phosphates was found to range from 0·4 p.p.m. in a sample of Florida soft phosphate to 188·2 p.p.m. in an Arkansas phosphate. Of the important commercial deposits, the average for North African phosphate was 17·4, for Florida land pebble 11·9, and for Florida hard rock 5·4 p.p.m. Two samples each from Nauru and Ocean Island gave values of 5·1 and 5·6, 7·9 and 9·7 p.p.m. respectively. Apatite from the Kola peninsula of the U.S.S.R. was found to contain 7·6 p.p.m. There appears to be no relationship either between the arsenic content of the phosphate and the geological age of the deposit, or between the arsenic content and the quantities of such constituents as phosphorus, iron, iron sulphide, carbon or nitrogen, but phosphates from primary deposits tend to contain more arsenic than those from secondary ones.

Superphosphate manufactured with sulphuric acid produced wholly or partly from pyrite contained arsenic in amounts varying from 494·1 to 1,199 p.p.m., whereas that made with acid produced from native sulphur contained only 2·2 to 35·7 p.p.m. Double superphosphate contained from 10·6 to 404·6 p.p.m. depending on the acid used in its manufacture, basic slag 2·1 to 11·2 p.p.m. and bone ash 0·2 to 2·2 p.p.m.

The method of analysis adopted involved the digestion of the sample with a mixture of sulphuric and nitric acids, the distillation of the arsenic as the trichloride and its determination by a colorimetric method. It was found that the presence of fluorine compounds caused serious errors in the determination unless arsenic-free glassware was used.

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The publications issued by the Governments of the Colonies and Protectorates can be obtained from or through the Crown Agents for the Colonies, 4 Millbank, Westminster, S.W.1. Applications for Dominion and Indian Government publications may be made to the Offices of the High Commissioners or Agents-General in London.

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BULLETIN
OF THE IMPERIAL INSTITUTE

VOL. XL. NO. 3. JULY-SEPTEMBER, 1942

PLANT AND ANIMAL PRODUCTS

ARTICLE

THE DETERMINATION OF ROTENONE IN DERRIS ROOT[1]

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An improved method for estimating rotenone in derris root, employing the carbon tetrachloride complex separation, is described. It has been shown by three groups of workers to give concordant results with various types of root. Methods of determining moisture content and chloroform extract are also given. Their adoption in the United Kingdom as standard methods is recommended.

OWING to the discordant results obtained by different analysts for the rotenone content of the same sample of derris root, the need for systematic work on the method of determination and a survey of the several methods and modifications of methods in use had made itself felt by the end of 1937. At that time both the Imperial Institute and the Rothamsted Experimental Station had independently commenced experimental work in this connection, when at the first meeting in November, 1937 of the newly-constituted Imperial Institute Consultative Committee on Insecticide Materials of Vegetable Origin a recommendation was passed that the two institutions should collaborate with a view to employing the same methods for the chemical evaluation of insecticides. Co-operative work immediately followed on the tentative methods of determining rotenone which each institution had already evolved, and many points relating to extraction-solvents and manipulative procedure were redetermined conjointly. Much patient investigational work was carried out, involving a considerable number of analyses of derris root.

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[1] Reprinted from the *Journal of the Society of Chemical Industry*, July, 1942, Vol. LXI, pp. 110—112, by kind permission of the Editor.

By the beginning of 1939 the advantages of establishing a reliable method of rotenone determination and securing its general acceptance over a wider field, viz., by the trade and interested institutions in the chief consuming countries, was realised. With this end in view it was decided to extend collaboration, and the co-operation of the Cooper Technical Bureau and the Chemical Division of the Agricultural Department, Federated Malay States, was readily obtained. The Royal Colonial Institute, Amsterdam, the Laboratory for Chemical Research, Buitenzorg, and the United States Department of Agriculture were approached, and they subsequently provided useful observations and data.

Under the Consultative Committee a Sub-Committee on Methods of Determining Rotenone was set up to go fully into the question and to draw up detailed proposals. It consisted of Dr. J. R. Furlong (Chairman), Imperial Institute, and Dr. R. S. Cahn and Dr. R. F. Phipers, Cooper Technical Bureau, in addition to the authors.

Two methods of determination which had been developed by the workers at the Imperial Institute and Rothamsted, and also the Jones and Graham method, were next submitted to trial by the collaborators independently at the Imperial Institute, Rothamsted, and the Department of Agriculture, Malaya, employing for the test four samples of derris root selected to cover the usual range of rotenone content. On the results obtained by the three institutions, it was possible to formulate a single method which promised to be capable of giving reliable results.

It became obvious during the early stages of the collaborative work that uniformity of results would depend, to a very large extent, on the rigid definition of the conditions required for each step of the determination. This fact has been proved by practical experiment and a considerable amount of work has been carried out in order to determine the optimum conditions for each stage of the determination. It is therefore strongly emphasised that all the conditions laid down in the method have been found necessary and failure to comply with them, although it may allow one worker to obtain satisfactory agreement in his own laboratory, will almost certainly yield results which are discordant with those obtained in other laboratories.

The tentative method now agreed on was subjected to a rigorous test with carefully prepared, uniform samples of six different kinds of derris, covering a wide range of rotenone content, by the workers at the Imperial Institute, Rothamsted, Cooper Technical Bureau, and in Malaya. They were as follows: No. 1, *Derris malaccensis*

(Kinta type); No. 2, *Derris malaccensis*, variety *sarawakensis*; No. 3, *D. elliptica* (Sarawak creeping type); No. 4, *D. elliptica* (Changi No. 3 type); No. 5, *D. elliptica* (Changi type); No. 6, blend of No. 1 with No. 5 in equal quantities.

The results obtained in Malaya were not in agreement with those obtained in England, and it is probable that temperature played an important part in causing the discrepancies. The agreement obtained by Rothamsted, the Cooper Technical Bureau, and the Imperial Institute for the rotenone determination of the six samples by the tentative method was closer and more consistent than anything previously achieved. The following table shows the maximum and minimum figures for each sample, together with the average figures for all the determinations by the three institutions, omitting Malaya, obtained in this last trial.

Sample.	Number of determinations.	Rotenone, % on the moisture-free material. Minimum figure.	Maximum figure.	Average figure.
1. *D. malaccensis* (Kinta) . .	12	0·2	0·7	0·5
2. *D. malaccensis* var. *sarawakensis*.	10	2·3	2·7	2·5
3. *D. elliptica* (Sarawak creeping) .	9	4·6	5·0	4·7
4. *D. elliptica* (Changi No. 3) .	9	9·8	10·4	10·2
5. *D. elliptica* (Changi) . .	9	9·9	10·25	10·0
6. Blend of No. 1 and No. 5, equal parts.	9	4·8	5·25	5·05

It is recognised that in order to adjust the method for use in tropical countries, further work is required which under the present war conditions cannot be carried out, but the success obtained in the above trial with the method in England shows that it is suitable for temperate climates and its adoption in the United Kingdom as a standard method for determining the rotenone content of derris root is recommended.

In view of the immediate need in the United Kingdom for a reliable method for determining rotenone, the method is made public, but owing to pressure of other work and in order to economise in publishing space, no attempt has been made to record in detail the research carried out, or to discuss the reasons for or against particular analytical operations. The description only of the method as finally approved is given, leaving for a future date the possibility of publishing the evidence which led to the adoption of the various operations concerned.

The methods recommended for the determination of the chloroform extract and the moisture content, the latter worked out by Mr. S. Brightwell (Imperial Institute), which form important related items in the analysis of derris root, are also given.

Preparation of Sample for Analysis.—The representative sample of roots is ground in stages until the whole of the sample passes a grid which has circular holes measuring $\frac{1}{64}$ in. in diameter. The whole of this ground material is then mixed in a ball mill for one hour.

Adherence to these instructions is considered essential for the success of the determination of rotenone by the method that follows.

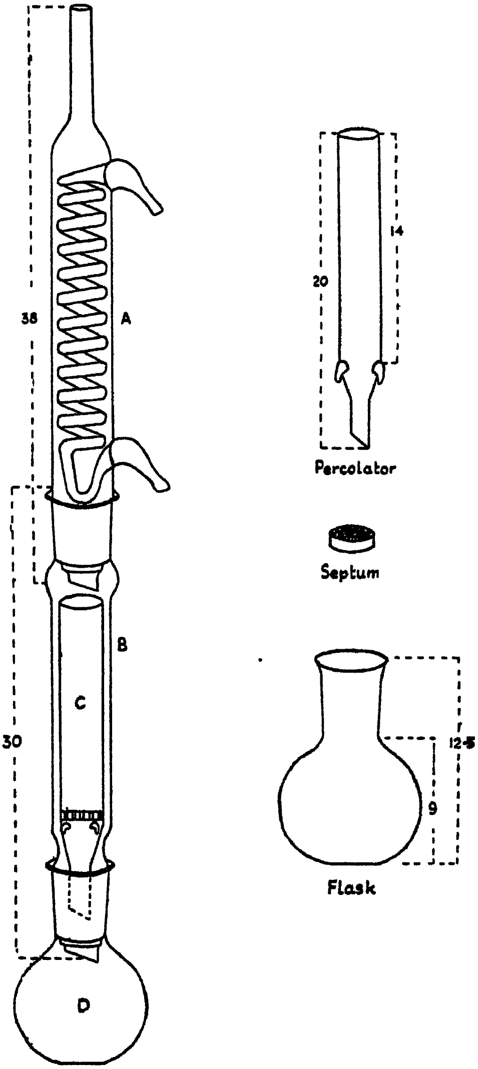
Determination of Moisture.—5 grams of the sample prepared for analysis are dried for 4 hours at 105°. For this purpose the material is evenly spread in a flat-bottomed, straight-sided evaporating dish or Petri dish, of 7-10 cm. diameter. It should be noted that this determination of moisture refers to the sample prepared for analysis. In order to calculate rotenone content of original roots a determination of moisture should be made on the roots in sliced condition.

Determination of Chloroform Extract.—The 50 ml. of chloroform extract (prepared by the hot percolation method described in the method for the determination of rotenone) are evaporated in a 100 ml. conical flask to about 15 ml. This solution is poured into a weighed, flat-bottomed, straight-sided evaporating dish or Petri dish, 7-10 cm. in diameter, and the flask rinsed out with chloroform into this dish. The bulk of the remaining solvent is removed by evaporation on the water-bath, and the final residue dried for 7 hours at 105°.

Determination of Rotenone.—The whole of the ground sample is removed from its container on to a piece of paper and intimately mixed before each analysis. 25 grams are weighed out, portions being drawn from different parts of the sample, and extracted by hot percolation with chloroform for 3 hours in the apparatus shown in Fig. 1. A septum consisting of a perforated porcelain or a glass disc is placed at the bottom of the percolator. On this is placed a pad of cotton wool. The weighed quantity of material is supported on this pad and is added slowly, while the percolator is gently tapped to ensure that no air pockets occur. At the same time care must be taken to avoid tight packing of the powder which would give rise to channels. The charge is covered with a further pad of cotton wool, and the whole kept in position by means of a loose glass stopper resting on the upper pad. Apart from this no pressure is put on the material.

The solvent (150 ml.) is placed in the flask and refluxed on a wire gauze over a small flame at such a rate as to keep the percolator just full. Percolation is maintained for 3 hours, the time being reckoned from the commencement of actual percolation. On completion of this extraction the solution is poured into a 250-ml. graduated flask, the extraction flask being thoroughly washed out with chloroform and the volume made up to 250 ml. 50 ml. of this solution are withdrawn by means of a pipette and delivered into a 100-ml. conical flask for determination of chloroform extract. The remaining 200 ml. are transferred to a 500-ml. Erlenmeyer flask and the graduated flask and pipette washed out with chloroform into this flask. The solvent is distilled off until only about 25 ml. of the solution remains in the flask.

The extract is transferred to a 100-ml. Erlenmeyer flask, using carbon tetrachloride to rinse out the 500-ml. flask, and evaporated almost to dryness on a steam-bath in a current of air, and then under reduced pressure (water pump) for 5 minutes, heating cautiously on the steam-bath meanwhile. The suction may be



Quickfit and Quartz numbers.

A Condenser	CX 3/07
B Outer jacket of percolator	EX 4/45
C Percolator	EX 4/40
D Flask (250 c.c.)	B34 Neck

FIG. 1

Dimensions in centimetres.

applied directly to the flask. The extract is dissolved in 15 ml. of hot carbon tetrachloride and the solvent again removed in a similar manner. The procedure is repeated with another 10-15-ml. portion of hot carbon tetrachloride. If small quantities of insoluble material are present, the purification procedure described later will eliminate them. However, if an appreciable quantity of insoluble residue remains when the extract is dissolved in the first portion of carbon tetrachloride, it should be filtered off and thoroughly washed with further portions of hot solvent, after which the filtered solution plus washings should be treated as directed previously for the removal of chloroform. 25 ml. of carbon tetrachloride saturated with rotenone (see Note A) are added and the whole is gently heated under a reflux condenser to effect dissolution. The flask is cooled in an ice-bath for several minutes and then seeded with a few crystals of rotenone-carbon tetrachloride complex, if necessary. The flask is stoppered and swirled until crystallisation is apparently complete. If at this stage only a small quantity of crystalline material separates 1·00 gram of pure rotenone (see Note A) should be added. The contents of the flask are then warmed to effect complete dissolution and crystallisation is again induced. The flasks containing the extract and the washing solution are placed in an ice-bath maintained at a temperature of 0° overnight. Next morning (after a minimum period of 16 hours) the crystals of complex are filtered by suction in a weighed Jena glass crucible, Gooch type, high form, fritted filter disc, No. 1 G3 (or British-made equivalent). The flask and crystals are rapidly washed with 10-15 ml. of ice-cold carbon tetrachloride (saturated with rotenone as described in Note A). This takes place in the open laboratory, the apparatus and solutions, however, having previously been cooled to 0°. The crucible is allowed to remain under suction for about 5 mins. and then dried at 40° for 1 hour.

The crucible is next stoppered with a cork at the bottom (at the edge beneath the filter-plate). 25 ml. of absolute alcohol saturated with rotenone (see Note B) are added in portions, with stirring, in order to break up the complex. A portion of the solvent is used to wash the spatula. The crucible is stoppered with a cork at the top and set aside at 0° for at least 4 hours, preferably overnight, at the same temperature. The alcohol is then removed by suction and the rotenone washed with 10 ml. of the absolute alcohol saturated with rotenone at 0° (see Note B) and dried to constant weight (*R*) at 105°. The crystals are removed from the crucible and well mixed on a sheet of glazed paper by means of a spatula. One gram. of this material is accurately weighed into a 50-ml. beaker and dissolved in 10-15 ml. of pure benzene, stirring with a glass rod. The solution is poured into a 25-ml. graduated flask and the beaker washed out with small quantities of benzene. The solution is brought to the temperature of 20° and made up to 25 ml. with benzene at that temperature.

The optical rotation of this 4% solution is determined at 20° in a polarimeter reading in circular degrees, using a 10-cm. tube, preferably fitted with a water jacket for controlling the temperature. The solution is cleared if necessary by centrifuging or allowing to settle. The percentage purity of the rotenone (*P*) is given by the formula $P=100\alpha/9{\cdot}04$, where α is the rotation, the value 9·04 being the angle of rotation (negative) in degrees of a 4% solution of pure rotenone in benzene at 20°.

The purity of the rotenone having been determined, the percentage of pure rotenone in the root as received is calculated as follows: (1) when no rotenone has been added, $R \times P \times 0{\cdot}05$; (2) when 1 g. of rotenone has been added, $5\{(R \times P/100) - 1\}$.

Note A.—The saturated solution of rotenone in carbon tetrachloride is prepared by dissolving 2·72 g. of pure rotenone in hot carbon tetrachloride, cooling, and making up to 1000 ml. at 0° . The pure rotenone is prepared by purifying a quantity of the carbon tetrachloride complex by first triturating it with cold absolute alcohol, converting the rotenone thus liberated into complex again, dissolving in hot absolute alcohol, and allowing the rotenone to crystallise out. The percentage purity of the rotenone so prepared is determined by measuring the optical rotation as described.

Note B.—The saturated solution of rotenone in alcohol is prepared by dissolving 1·244 g. of pure rotenone in absolute alcohol and making up to 1000 ml. at 0°.

Note C.—The chloroform, carbon tetrachloride, and benzene used in this determination are all of " AnalaR " quality.

Special thanks are due to the Adviser on Agriculture, Straits Settlements and Federated Malay States, for supplying correctly-named samples of the roots of the different species and races of derris examined; and to the Cooper Technical Bureau, Berkhamsted, for valuable assistance in grinding, mixing, and packing the samples as required for examination.

Drs. Martin and Harper are indebted to the Ministry of Agriculture and the Colonial Development Fund for grants which made co-operation in these investigations possible.

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The Processing of Jute for Papermaking. By B. P. Ridge and A. H. Little. *Paper Mkrs'. Assoc. Gr. Brit. and Ireland*, 1941, **22**, 53-110.

Jute Cuttings for Paper Pulp. By M. P. Bhargava and A. N. Nayer. *For. Bull. No.* 103, *Util.* (*New Series*), 1941, *For. Res. Inst., India.* Pp. 5, 9¾ × 7¼. (Delhi: Manager of Publications, 1941.) Price As. 3.

Straw for Papermaking: Yesterday, To-day and To-morrow. By J. Grant. *Paper Mkrs'. Assoc. Gr. Brit. and Ireland*, 1941, **22**, 9-51.

Wrapping and Packing Papers from *Ulla* Grass, *Themeda arundinacea* Ridley [*Anthistiria gigantea* Cav.]. By M. P. Bhargava and C. Singh. *For. Bull. No.* 100, *Util.* (*New Series*), *For. Res. Inst., India.* Pp. 13, 9½ × 7¼. (Delhi: Manager of Publications, 1941.) Price As. 6.

Report on the Use of Wood-Waste in Paper-making. By J. Strachan. *Paper Mkrs'. Assoc. Gr. Brit. and Ireland*, 1941, **22**, 111-126.

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Rubber

Rubber Investigations in Ceylon. By T. E. H. O'Brien. *Emp. J. Exp. Agric.*, 1942, **10**, 61-76.

Increasing the Crops from Ceylon Rubber Estates. *Adv. Circ. No.* 16, *Rubb. Res. Scheme, Ceylon.* Pp. 5, 9½ × 7. (Argalawatta, Ceylon: Research Laboratories, 1942.)

Wild Rubber in East Africa. By P. J. Greenway. *E. Afr. Agric. J.*, 1942, **7**, 224-227. Describes the most important sources of latex, viz., *Clitandra orientalis*, *Funtumia elastica*, *Landolphia* spp. and *Mascarenhasia elastica.*

The History of Rubber Production in South Africa. Experiments and Exports of Byegone Days. *S. Afr. Min. Engng. J.*, 1942, **53**, Part 1, 317-323. A study of the possibilities of the economic exploitation of South Africa's resources of wild rubber from the *Landophia* vine and *Euphorbia* spp.

Rubber from the Euphorbia. Research Work now in Progress. By D. S. Harris and S. G. Shuttleworth. *J. Dep. Comm. Industr., Un. S. Afr.*, 1942, **4**, No. 10, 315-317.

Korte Mededeeling van het Besoekisch Proefstation. Een nieuwe beschadiging aan Hevea door wantsen. By R. van der Veen. *Bergcultures*, 1941, **15**, 1764-1765. An account of new damage to Hevea by a bug (*Nysius* sp.).

Tobacco

Physiological Studies with the Tobacco Plant. By G. M. Ward. *Pub. No.* 729, *Dep. Agric. Canada.* Pp. 100, 10 × 6½. (Ottawa: King's Printer, 1942.)

Insect Pests of Cigar-type Tobaccos in the Southern Districts. By F. S. Chamberlin and A. H. Madden. *Circ. No.* 639, *U.S. Dep. Agric.* Pp. 54, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1942.) Price 15 cents.

Yellow Dwarf of Tobacco in Australia. 3. Occurrence and Effect of Agronomic Practices. By A. V. Hill and F. E. Allan. *J. Coun. Sci. Industr. Res. Aust.*, 1942, **15**, 13-25.

Gas Treatment for the Control of Blue Mold Disease of Tobacco. By E. E. Clayton and others. *Tech. Bull. No.* 799, *U.S. Dep. Agric.* Pp. 38, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1942.) Price 10 cents.

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Ergot. By J. C. Neill. *N.Z. J. Sci. Tech.*, 1941, **23**, 130A-137A. Describes the occurrence in New Zealand and life-history of ergot and gives an account of experiments on the commercial production of ergot on rye.

Meadow Saffron (*Colchicum autumnale*). *Adv. Leafl. No.* 285, *Minist. Agric. Lond.* Pp. 2, 8½ × 5½. (London: H.M. Stationery Office, 1942.) Price 1*d*. Gives methods of control to prevent poisoning of livestock and a note on its medicinal use.

A Phytochemical and Pharmacological Study of the Berries of *Phytolacca americana* Linn. (Fam. Phytolaccaceæ). By L. D. Jack and C. H. Rogers. *J. Amer. Pharm. Assoc., Scientif. Ed.*, 1942, **31**, 81-84.

Medicinal Products from *Pinus longifolia* Tar. By T. P. Ghose and B. S. Varma. *Indian For. Leafl. No.* 12 (*Chem.*), *For. Res. Inst.* Pp. 6, 8½ × 5. (Dehra Dun, U.P.: Forest Research Institute, 1942.)

Miscellaneous Agricultural Products

Value of Molasses. *Aust. Sug. J.*, 1942, **33**, 453-460. Results of an investigation into the value of molasses when used for the manufacture of alcohol.

Anaerobic Decomposition of Wheat Straw by Thermophiles and the Quantity of Gas Produced. By R. P. Straka, G. H. Nelson and M. Levine. *J. Agric. Res.*, 1942, **64**, 129-144. Discusses the determination of utilisable gas produced from fibrous farm wastes.

Livestock and Animal Products

Proceedings of the Fourth Meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry in India, Imperial Council of Agricultural Research, 1940. Pp. 250, 9¾ × 6¼. (Delhi: Manager of Publications, 1942.) Price Rs. 5 As. 10.

Annual Administration Report of the Civil Veterinary Department, United Provinces, for 1940-41. Pp. 27, 9½ × 6½. (Allahabad: Superintendent, Printing and Stationery, 1941.) Price As. 3 Ps. 6.

Annual Report of the Veterinary Department, Uganda, for 1941. Pp. 6, 9¾ × 6. (Entebbe: Government Printer, 1942.) Price Sh. 1/-.

"Grading Up" Bombay Province's Village Cattle. Importance of Premium Bull Schemes. *Leafl. No.* 4 *of* 1941, *Dep. Agric. Bombay.* Pp. 8, 10 × 6½. (Bombay: Department of Agriculture, 1941.)

Experimental Breeding of Dairy Cattle for the Tropics. By E. Harrison. *Trop. Agric., Trin.*, 1942, **19**, No. 4, 65-69.

Scheme for Control of Diseases of Dairy Cattle. *J. Minist. Agric.*, 1942, **49**, 12-18.

Internal Parasites of Cattle. By G. Dikmans. *Circ. No.* 614, *U.S. Dep. Agric.* Pp. 39, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1942.) Price 10 cents.

"Quick-time" Pasteurisation of Milk. By A. C. Dahlberg, R. F. Holland and R. K. Miner. *Tech. Bull. No.* 261, *N. Y. St. Agric. Exp. Sta.* Pp. 15, 9 × 6. (Geneva, N.Y.: Agricultural Experiment Station, 1941.)

Sheep Breeding and the Improvement of Sheep and Wool in the Bombay Province. *Leafl. No.* 5 *of* 1940, *Dep. Agric. Bombay.* Pp. 8, 10 × 6½. (Bombay: Department of Agriculture, 1940.)

Some Common Breeds of Indian Sheep. II. By R. L. Kaura. *Indian Frmg.*, 1942, **3**, No. 3, 122-125.

Enzootic Ataxia and Copper Deficiency of Sheep in Western Australia. By H. W. Bennetts and A. B. Beck. *Bull. No.* 147, *Coun. Sci. Industr. Res. Aust.* Pp. 52, 9¾ × 6. (Melbourne: Government Printer, 1942.)

Soybean-meal as a Source of Protein in Poultry Rations. By A. M. Gericke and J. A. van der Merwe. *Frmg. S. Afr.*, 1942, **17**, 310-318, 336, 340.

Observations on the Value of Whale-Meat Meal as a Constituent of Chick Diets, with a Note on the Influence of Added Protein on the Efficiency of Utilisation of the Gross Energy of a Ration. By E. T. Halnan. *J. Agric. Sci.*, 1942, **32**, 179-193.

Concentrate Feeding of Turkeys. By E. I. Robertson and J. S. Carver. *Bull. No.* 402, *Wash. Agric. Exp. Sta.* Pp. 15, 9 × 6. (Pullman, Washington: Agricultural Experiment Station, 1941.)

Report of the Fisheries Department, British Columbia, for 1940. Pp. 111, 10 × 7. (Victoria, B.C.: King's Printer, 1941.)

Some Bacteriological Aspects of Fish Preservation. By J. M. Shewan. *Chem. and Indust.*, 1942, **61**, 312-314.

FORESTRY

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Report of the Forest Branch, Department of Lands, British Columbia, for 1940. Pp. 101, 10 × 7. (Victoria, B.C.: King's Printer, 1941.)

Report on the Department of Lands and Forests, Province of Nova Scotia, 1941. Pp. 83, 9¾ × 6½. (Halifax, N.S.: King's Printer, 1942.)

Forest Research in India, 1940-41. Part 2. Reports for Burma and Indian Provinces. Pp. 242, 9½ × 6½. (Delhi: Manager of Publications, 1942.) Price Rs. 3 As. 12.

Forest Administration Report of the Province of Bombay for the year 1940-41. Part 1. Pp. 59, 9½ × 6. (Bombay: Superintendent, Government Printing and Stationery, 1942.) Price As. 6.

Report on Forest Administration in the United Provinces for the year 1940-41. Pp. 47, 9 × 6. (Allahabad: Superintendent, Printing and Stationery, 1941.) Price As. 7.

Report on the Forest Administration of Sierra Leone for 1941. Pp. 12, 9½ × 6. (Freetown: Government Printer, 1942.)

Twenty-first Annual Report of the Southern Forest Experiment Station, United States Department of Agriculture, for 1941. Pp. 21, 10½ × 8. (New Orleans, La.: Southern Forest Experiment Station, 1942.)

Investigations into Artificial Regeneration Details of the Dry Fuel Forests of Madras. By A. L. Griffith. *Indian For. Rec.* (*New Series*) *Silvic*, 1941, **4**, No. 4. Pp. 62, 9¾ × 7½. (Delhi: Manager of Publications, 1941.) Price Rs. 2 As. 8.

Control of the Locust Borer (*Cyllene robiniæ*). By R. C. Hall. *Circ. No.* 626, *U.S. Dep. Agric.* Pp. 19, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1942.) Price 5 cents. A destructive insect of forest and shade-trees in United States and Canada.

Fungi Causing Decay of Living Oaks in the Eastern United States and Their Cultural Identification. By R. W. Davidson, W. A. Campbell and D. B. Vaughn. *Tech. Bull. No.* 785, *U.S. Dep. Agric.* Pp. 65, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1942.) Price 15 cents.

Some Growth Characteristics of Red Spruce (*Picea rubra*). By W. M. Robertson. *Silvic. Res. Note No.* 70, *For. Serv. Canada.* Pp. 7, 10¾ × 8¼. (Ottawa: Department of Mines and Resources, 1942.)

Pruning Southern Pines. By W. R. Mattoon. *Frms'. Bull. No.* 1892, *U.S. Dep. Agric.* Pp. 34, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1941.) Price 10 cents.

Treatment of White Pines Infested with Blister Rust. By J. F. Martin and G. F. Gravatt. *Frms'. Bull. No.* 1885, *U.S. Dep. Agric.* Pp. 28, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1941.) Price 10 cents.

Decay in Red-Stained Jack Pine (*Pinus banksiana*) Ties Under Service Conditions. By C. W. Fritz and E. A. Atwell. *Circ. No.* 58, *For. Serv. Canada.* Pp. 19, 11 × 8½. (Ottawa: King's Printer, 1941.)

A Note on Semal (*Bombax malabaricum* D.C.). By Jagdamba Prasad. *For. Bull. No.* 107, *Silvic.* (*New Series*), 1941, *For. Res. Inst., India.* Pp. 15, 9½ × 7½. (Delhi: Manager of Publications, 1942.) Price As. 14. Silvicultural characteristics and distribution are described.

Forestry Charcoal Production. By S. Marian. *Quart. J. For.*, 1942, **36**, 54-59. Discusses the conversion of "waste" wood into charcoal.

Timber

Australian Standard Grading Rules (Emergency Series) for Sawn and Hewn Structural Timbers. *Emergency Stand. No.* (E) O.54—1942, *Stand. Assoc. Aust.* Pp. 10, 13 × 8. (Sydney: Standards Association of Australia, 1942.) Price 1*s*.

Testing of Indian Timbers for Veneers and Plywood. *Indian For. Rec.* (*New Series*) *Util.*, 1941, **2**, No. 4. Pp. 106, 9¾ × 7¼. (Delhi: Manager of Publications, 1941.) Price As. 9.

The Variation of the Electrical Resistance of Indian Timbers with Moisture Content. By D. Narayanamurti. *Bull. No.* 105 (*New Series*), *Util.*, 1941, *For. Res. Inst., India.* Pp. 7, 9½ × 7½. (Delhi: Manager of Publications, 1941.) Price As. 8.

Experiment on the Air Seasoning of *Pinus longifolia* (Chir) Sleepers in the East Almorah Division, U.P. By M. A. Rehman. *Indian For. Rec.* (*New Series*) *Utiliz.*, 1940, **2**, No. 5. Pp. 40, 9¾ × 7¼. (Delhi: Manager of Publications, 1941.) Price Re. 1 As. 2.

The Durability of Some Uganda Timbers and Poles in the Ground. By R. G. Sangster. *E. Afr. Agric. J.*, 1942, **7**, 122-126, 208-211.

Results of the Examination of Six Ground Line Treatments on Eastern White Cedar Poles after Two Years' Service. By J. F. Harkom, M. J. Colleary and H. Sedziak. *Rep. No.* 136, *For. Serv. Canada.* Pp. 18, 13 × 8. (Ottawa Canada: Forest Products Laboratories, 1942.)

The Preservation of Timber. By R. L. Brooks. *J. Inst. Petrol.*, 1942, **28**, 63-81. Has special reference to conditions in Trinidad.

Wood Flour for Dry Electric Cells. By S. V. Puntambekar and S. Krishna. *For. Bull. No.* 101, *Chem.* (*New Series*), 1941, *For. Res. Inst., India.* Pp. 4, 9¾ × 7¼. (Delhi: Manager of Publications, 1942.) Price As. 3.

Gums and Resins

Annual Report of the Indian Lac Cess Committee for the year April 1, 1940, to March 31, 1941. Pp. 8½ × 5½. (Ranchi, Bihar: Indian Lac Cess Committee, 1941.)

Manila Gums. The Use of Manila Copals in Bright Drying Floor Waxes. By R. W. Allan. *Soap*, 1941, No. 12, 118-121, 147.

Development of Naval Stores and Pulpwood Supplies from the *Pinus mercusii* of Northern Sumatra. By D. G. Moon. *Paper Tr. J.*, 1942, **114**, No. 16, 34-37.

IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 19

(April to June, 1942.)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

GENERAL

The Use of Concentrated Sprays for Pea Aphid Control. By H. Glasgow. *Bull. No.* 698, *New York St. Agric. Exp. Sta.*, 1942, p. 12. Particulars of the efficiency of nicotine and rotenone concentrated sprays.

Contributions to Codling Moth Control. By S. W. Harman. *Bull. No.* 698, *New York St. Agric. Exp. Sta.*, 1942, p. 17. Discusses methods for shortening the codling moth spray programme, experiments with rotenone, pyrethrum and other organic insecticides and the use of nicotine as a fortifying agent for lead arsenate sprays.

Squash Vine Borer Control. By G. E. R. Hervey. *Bull. No.* 698, *New York St. Agric. Exp. Sta.*, 1942, p. 20. Gives a summary of five years experiments: rotenone, nicotine and derris were tested.

Use of Dusts for European Corn Borer Control. By L. A. Carruth. *Bull. No.* 698, *New York St. Agric. Exp. Sta.*, 1942, p. 35. Dual-fixed nicotine dust and 1 per cent. rotenone dust give comparable borer control.

Aphides, with Special Reference to their Control. By G. Fox-Wilson. *J. Roy. Hort. Soc.*, 1942, **67**, Pt. 6, 199-205. Discusses the effects of nicotine, derris, pyrethrum and quassia.

Insects Associated with the Coconut Palm. Part 2. By J. L. Froggatt and B. A. O'Connor. *New Guinea Agric. Gaz.*, 1941, **7**, No. 2, 125-133. (*R.A.E.*, 1942, **30**, A, Pt. 4, 159.) Dusts of derris or pyrethrum gave poor results against *Promecotheca papuana*; nicotine sulphate spray most satisfactory.

The Beet Web-worm (*Hymenia recurvalis*). *Agric. Gaz. N.S.W.*, 1941, **52**, 322-323. (*R.A.E.*, 1942, **30**, A, Pt. 5, 231.) Tests showed that derris dusting powders effective against the larvæ; pyrethrum not superior to derris and more expensive.

Fifty-first Annual Report of the Agricultural Experiment Station, Pullman, Washington, for the year ended June 30, 1941. Nicotine in combination with oil for the control of codling moth gave no outstanding results; sprays of rotenone-bearing materials were effective on orchard mites but failed to destroy eggs; pyrethrum and rotenone-material dusts controlled the asparagus beetle (*Crioceris asparagi*); dusts of pyrethrum or rotenone failed to control the strawberry aphid; cranberry tip worm can be controlled by rotenone sprays; rotenone in solution in sprays gave a higher kill of fireworm and fruitworm than when in suspension, and rotenone and pyrethrum in combination gave higher percentage than either alone on these insects.

Report of the Chief of the Bureau of Entomology and Plant Quarantine, U.S. Department of Agriculture, 1941. Discusses work done on insecticides of vegetable origin, p. 102.

Field Experiments for the Control of the Mullein Leaf Bug, *Campylomma verbasci* Meyer, in Nova Scotia Apple Orchards. By A. D. Pickett, N. A. Patterson, J. MacB. Cameron and M. E. Neary. *Rep. Ent. Soc. Ontario*, 1940, 23-25. (*R.A.E.*, 1942, **30**, A, Pt. 3, 109.) Dusts and sprays of pyrethrum, nicotine sulphate and rotenone tested.

Relationship of Insects to the Spread of Azalea Flower Spot. By F. F. Smith and F. Weiss. *Tech. Bull. No.* 798, *U.S. Dep. Agric.*, 1942, p. 39-40. Discusses the effect of derris, pyrethrum and nicotine dusts and sprays on bees.

Gladiolus Diseases and Insects. By L. McCulloch and C. A. Weigel. *Frms'. Bull. No.* 1860, *U.S. Dep. Agric.*, 1941. Nicotine or pyrethrum sprays successful against aphids.

Control of the European Corn Borer by Sprays and Dusts. By N. Turner. *Circ. No.* 147, *Conn. Agric. Exp. Sta.*, 1941, 35-43. (*Amer. Chem. Absts.*, 1942, **36**, No. 4, 1135.) Nicotine and rotenone-containing dusts compared.

Ox Warble-fly Control. *Indian Frmg.*, 1942, **3**, 33-34. Experiments carried out at the Government Cattle Farm, Hissar, to test the relative larvicidal values of tobacco-lime infusion and derris-soap wash.

Controlling Bot and Warble Flies of Livestock in Missouri. By L. Haseman and W. E. Roland. *Bull. No.* 430, *Missouri Agric. Exp. Sta.*, 1941. (*Amer. Chem. Absts.*, 1942, **36**, No. 8, 2369.) Derris, pyrethrum, and nicotine among the effective chemicals for treating the warbles.

Fruit Insect Studies of 1940. By S. C. Chandler and W. P. Flint. *Trans. Illinois Hort. Soc.*, 1941, **74**, 131-149. (*Amer. Chem. Absts.*, 1942, **36**, No. 8, 2367.) Fixed nicotine sprays not so effective as lead arsenate for control of codling moth; nicotine not so effective in controlling the leaf roller on apple trees; nicotine and pyrethrum sprays and pyrethrum dusts gave excellent control of leaf hoppers.

Control of Grape Diseases and Insects in the Eastern United States. By J. B. Demaree and G. A. Runner. *Frms'. Bull. No.* 1893, *U.S. Dep. Agric.*, 1942, p. 26-27. Nicotine sulphate and pyrethrum or derris sprays recommended.

The Carrot Rust Fly. By A. J. Hanson and R. L. Webster. *Bull. No.* 405, *Washington Agric. Exp. Sta.*, 1941, 21. Cube, derris and cedar sawdust among the insecticides which gave unsatisfactory control.

The European Corn Borer. Its Present Status and Methods of Control. By D. J. Caffrey and W. A. Baker. *Frms'. Bull. No.* 1548 (*Revised*), *U.S. Dep. Agric.*, 1941, p. 36. Sprays of derris or cube practical and satisfactory for the more valuable crops; tank-mixed nicotine tannate sprays in some cases satisfactory; dusts of either nicotine or rotenone variable in results.

Insects of the Blackberry, Raspberry, Strawberry, Currant, and Gooseberry. By A. J. Hanson and R. L. Webster. *Pop. Bull. No.* 164, *Wash. Agric. Exp. Sta.*, 1941. Nicotine, derris and rotenone are among the insecticides recommended for the control of the various pests attacking the fruits.

Insect Pests. *Agric. Gaz. N.S.W.*, 1942, **53**, Pt. 3, 132-136. Spraying with nicotine sulphate and white oil emulsion recommended for control of the bean fly (*Agromyza phaseoli*); derris or pyrethrum dusts suggested for the control of cat and dog fleas, also pyrethrum-kerosene sprays.

Insecticidal Plants in the Americas. By E. C. Higbee. *Bull. Pan Amer. Un.*, 1942, **76**, No. 5, 252-257. Notes on the occurrence of Lonchocarpus, *Tephrosia virginiana, Nicotiana tabacum, Chrysanthemum cinerariæfolium*, sources of anabasine, *Haplophyton cimicidum, Petiveria alliacea,* and other minor and lesser known insecticides.

New Industries in Latin America. By D. M. Tercero. *Bull. Pan Amer. Un.*, 1942, **76**, 99, 100. Refers to the production of pyrethrum in Chile and attempts being made in Brazil to produce plantation timbo.

What a Cowman expects of a Cowspray. By A. O. Shaw. *Soap*, 1942, **18**, No. 2, 90-93.

Repellency in Cattle Sprays. By T. H. Mailen and R. A. Fenton. *Soap*, 1941, **17**, No. 12, 133.

Flea and Louse Control. *Soap*, 1941, **17**, No. 12, 115. Pyrethrum and rotenone mentioned.

Fumigation by Smokes with special reference to Derris and Pyrethrum. By S. T. P. Brightwell. *Bull. Imp. Inst.*, 1942, **40**, No. 1, 6.

All Purpose Insect Spray. Some Considerations in Favour of a Single Type Fly Spray for Home, Institutional and Stock Spray Purposes. *Soap*, 1942, **18**, No. 5, 97, 99, 101.

Studies of Contact Insecticides. XV. An Insect Toximeter. By W. C. O'Kane, L. C. Glover and R. L. Blickle. *New Hampshire Sta. Tech. Bull.*, 1941, **76**, 10. (*Exp. Sta. Rec.*, 1942, **86**, 508.)

Stabilised Insecticide. *Soap*, 1942, **18**, No. 4, 115. Canadian Patent No. 401, 965 dealing with stabilisation of rotenone and pyrethrum insecticides.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Annual Report of the Council for Scientific and Industrial Research, Australia, for 1940-41. P. 26 refers to the successful use of a mixture of tobacco dust, slaked lime and kerosene against the red-legged earth mite (*Halotydeus destructor*).

Annual Report Department of Agriculture, United Provinces, for the year ending June 30, 1940, p. 30. Combined soft soap nicotine spray as a control for leaf-curling peach aphis being studied; has been found effective against woolly aphis in summer.

Tobacco to replace Derris and Pyrethrum. *Mfg. Chem.*, 1942, **13**, 145-146. Research being carried out to find industrial uses for tobacco in U.S.A.; new series of double salts of nicotine prepared for insecticidal purposes.

Tomato Pests. *Agric. Gaz. N.S.W.*, 1941, **52**, Pt. 3, 171-175. (*R.A.E.*, 1942, **30**, A, Pt. 3, 100.) Most satisfactory control of *Macrosiphum solanifolii* given by a spray of nicotine sulphate and Bordeaux mixture.

Control of the Codling Moth in Baluchistan. By A. M. Mustafa and Nazeer Ahmed Janjua. *Indian Frmg.*, 1942, **3**, 76. Kerosene-nicotine sulphate emulsion most effective but too expensive.

Practical Control of the European Corn Borer. By N. Turner. *Connecticut Vegetable Growers' Assoc., Proc. Ann. Meeting*, 1940, **28**, 65-66. (*Amer. Chem. Absts.*, 1942, **36**, No. 7, 2075.) Dusting early sweet corn with dual-fixed nicotine dust was profitable and commercially feasible.

Dormant Treatments for the Control of Certain Insects on Nursery Plants. By F. L. Gambrell. *Bull. No.* 698, *New York St. Agric. Exp. Sta.*, 1942, p. 22. Compares the effectiveness of dinitro compounds with a number of other insecticides, including nicotine, against such pests as spruce gall aphid, Sitka gall aphid and snowball aphid.

A Shortened Intensive Summer Spray Programme for Apples in Eastern New York. By O. H. Hammer and D. W. Hamilton. *Bull. No.* 698, *New York St. Agric. Exp. Sta.*, 1942, p. 32. Nicotine included in the first, second and third cover sprays.

Studies on the Control of the Grape-berry Moth. By E. F. Taschenberg and F. Z. Hartzell. *Bull. No.* 698, *New York St. Agric. Exp. Sta.*, 1942, p. 45. Nicotine recommended in the spray programme.

Insecticides for Oriental Fruit Moth Control. By R. W. Dean. *Bull. No.* 698, *New York St. Agric. Exp. Sta.*, 1942, p. 53. Tests with fixed nicotine spray did not give very satisfactory results.

The Oriental Fruit Moth in Missouri. By C. W. Wingo. *Bull.* No. 424, *Missouri Agric. Exp. Sta.* (*R. A. E.*, 1942, **30**, A, Pt. 5, 225.) Summer oil and nicotine sulphate spray recommended.

Plum Aphides. *Adv. Leafl. No.* 34, *Minist. Agric. Lond.*, p. 4. Nicotine wash effective.

The Control of Potato Aphids on Long Island. By J. O. Nottingham and W. A. Rawlins. *Amer. Potato J.*, 1941, **18**, No. 11, 305-311. (*Exp. Sta. Rec.*, 1942, **86**, No. 4, 510.) Nicotine spray and nicotine vapour give excellent control.

The Use of Eradicant Sprays for Controlling Apple Scab (*Venturia inæqualis*) in Illinois, 1940 Results. By D. Powell, H. W. Anderson and R. Kohn. *Trans. Illinois Hort. Soc.*, 1941, **74**, 213-234. (*Amer. Chem. Absts.*, 1942, **36**, No. 7, 2074.) Nicotine sprays were not effective in preventing secondary infection.

Die Permeabilität der Haut für Nicotin. By H. Willenbücher. *Inaug. Diss., Hanover*, 1940. (Abst. in *Vet. Bull.* 1942, **12**, No. 5, 305.) The permeability of the skin to nicotine.

Substitute Spray Materials. II. By C. G. Vinson and S. A. McCory. *Bull. No.* 316, *Mo. Agric. Exp. Sta.*, 1940, p. 14. (*Brit. Chem. and Phys. Abstr.*, 1942, BIII, p. 99.) Nicotine-bentonite cover sprays as effective as lead arsenate sprays in controlling codling moth and producing clean fruit.

Antiparasitic Compositions. U.S. Patent No. 2134917. *Brit. Chem. and Phys. Abstr.*, 1942, BIII, 148. Nicotine salts of partial esters of certain fatty acids and polyhydric alcohol monosulphates.

Other Alkaloid-containing Materials

The Biology of *Thrips linarius* Uz. and Control Measures Against It. By M. F. Ermolaev. *Bull. Plant Prot., U.S.S.R.*, 1940, No. 3, 23-34. (*R. A. E.*, 1942, **30**, A, Pt. 5, 234-235.) Field experiments indicated a marked reduction in infestation on spraying with 0·3 or 0·2 per cent. anabasine sulphate in 0·4 per cent. soap solution.

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

The Problem of the Evaluation of Rotenone-containing Plants. VI. The Toxicity of l-Elliptone and of Poisons Applied Jointly, with further Observations on the Rotenone Equivalent Method of Assessing the Toxicity of Derris Root. By J. T. Martin. *Ann. Appl. Biol.*, 1942, **29**, No. 1, 69-81.

Prohibit Rotenone Use in Household Products. *Soap*, 1942, **18**, No. 5, 115. Restrictions on the use of rotenone in sprays for certain food crops and prohibitions on its uses in household products in U.S.A.

Sale of Rotenone Products now banned in the U.S.A. except for Agricultural Purposes. *Soap*, 1942, **18**, No. 3, 87.

Lower Concentrations of Rotenone. By H. F. Wilson and R. L. Janes. *Soap*, 1942, **18**, No. 3, 93. Suggests that the rotenone content of agricultural dusts may be safely reduced.

Carriers of Rotenone Dusts. By H. F. Wilson and R. L. Janes. *Soap*, 1942, **18**, No. 4, 103-105.

Two Experiments which show Promising Control of the Columbine Borer *Papaipema purpurifascia*. By W. G. Matthewman. *Rep. Ent. Soc. Ontario*, 1940, 26-29. (*R. A. E.*, 1942, **30**, A, Pt. 3, 109.) Derris and rotenone dusts effective.

Cabbage Caterpillars. By C. L. Walton. *J. Minist. Agric. Lond.*, 1942, **48**, No. 4, 243-246. Readily controlled by applications of sprays or dusts containing derris or lonchocarpus.

Squash Borer (*Melittia satyriniformis*). *Picture Sheet No.* 10, *Bur. Entomol. Plant Quarantine, U.S. Dep. Agric.*, 1941. Dust mixture of derris or cube diluted with inert diluent, or a spray of nicotine sulphate are recommended.

Studies of Rotenone Sprays for Cabbage Worm Control. By G. E. R. Hervey. *Bull. No.* 698, *New York St. Agric. Exp. Sta.*, 1942, p. 48.

Recent Investigations on Cherry Fruitflies. By D. W. Hamilton. *Bull. No.* 698, *New York St. Agric. Exp. Sta.*, 1942, p. 43. Rotenone-bearing materials may be used as substitutes for lead arsenate.

Bull. No. 405, *Maine Agric. Exp. Sta.*, 1941. (*Amer. Chem. Absts.*, 1942, **36**, No. 9, 2671.) Refers to (*a*) the control of the striped cucumber beetle by a dust containing rotenone and (*b*) the Mexican bean beetle, after the pods formed, by rotenone.

Pea Aphids as a Factor in Growing Peas on Long Island. By H. C. Huckett. *Bull. No.* 698, *New York St. Agric. Exp. Sta.*, 1942, p. 31. Protective applications of rotenone dust or standard rotenone spray (derris root) beneficial.

Insecticidal Control of the Raspberry Cane Borer. By F. G. Mundinger. *Bull. No.* 698, *New York St. Agric. Exp. Sta.*, 1942, p. 29. Derris and rotenone tested : derris sprays gave the best control.

What's New ? What is it Worth ? *J. Amer. Pharm. Assoc.*, 1942, **3**, No. 2, 63. Refers to the use of rotenone in treatment of scabies and chigger-mite dermatitis.

Comparison of Larvicides. By C. E. Smith, E. Livengood and I. H. Roberts. *J. Amer. Vet. Med. Assoc.*, 1942, **99**, 391-394. (Abst. in *Soap*, 1942, **18**, No. 4, 107.) Pure rotenone preparations not so effective as derris or cube washes.

Rotenone in Low Concentration as a Tickicide and Insecticide for House Pets. Z. de Jesus and R. B. Gapuz. *Philipp. J. Anim. Industr.*, 1940, **7**, No. 4, 391-395. (*R.A.E.*, 1942, **30**, B, Pt. 3, 36.)

The Treatment of Scabies. By H. Skinner. *Soap, Perf. and Cosmetics*, 1942, **15**, No. 5, 250-252. Formulas for the use of derris and rotenone are given.

U.S. Patents No. 2,265,155 and No. 2,265,156. Insecticidal compositions comprising rotenone and rotenone-containing derris-type resins in combination with certain chemical compounds. *Soap*, 1942, **18**, 65.

U.S. Patent No. 2,264,372. An insecticidal material comprising a rotenone product, a petroleum oil and a phenol derived from Anacardiaceæ family of plants. *Soap*, 1942, **18**, No. 2, 65.

U.S. Patent No. 2,267,385. Insecticides prepared by extracting rotenone-containing roots. *Amer. Chem. Absts.*, 1942, **36**, No. 9, 2677.

Stabilised Insecticidal Compositions suitable for Combatting Moths, Beetles, etc. U.S. Patent No. 2,268,353. Made from derris root, rotenone, timbo root, cube root or pyrethrum flowers. *Amer. Chem. Absts.*, 1942, **36**, No. 9, 2677.

Derris

Annual Report of the Department of Agriculture, Zanzibar, for 1941. Derris grown at Kizimbani gives maximum yield of rotenone about 2½ years from date of planting.

Derris in French Indo-China. *Foreign Comm. Wkly.*, 1942, **6**, No. 3, 17.

Laboratory and Field Tests of Toxicity of Some Organic Compounds to the European Corn Borer. By D. D. Questel, S. I. Gertler, L. S. Smith and D. L. Vivian. *U.S. Dep. Agric., Bur. Entomol. Plant Quarantine* E.—557. None of the compounds tested proved as satisfactory protection as derris.

Attractants and Repellents for Insects. By E. G. Thomssen and M. H. Doner. *Soap*, 1942, **18**, No. 5, 95-96, 105. Mentions that the Japanese beetle *Papillia japonica* is effectively repelled from foliage treated with sprays containing derris.

Improved Control of *Alternaria solani* (Early Blight) on Tomatoes by Controlling Flea Beetles. By J. W. Heuberger. *Phytopathology*, 1942, **32**, No. 1, 8. (*R.A.E.*, 1942, **30**, A, Pt. 5, 227.) Derris added to dusts or sprays of copper compounds gave better results than copper compounds alone.

Spraying for the Control of the European Corn Borer in Sweet Corn. By G. M. Stirrett and R. W. Thompson. *Rep. Ent. Soc. Ontario*, 1940, 9-15. (*R.A.E.*, 1942, **30**, A, Pt. 3, 107.) Tests with sprays of derris and cryolite carried out: derris most profitable.

Apple Blossom Weevil. *Adv. Leafl. No.* 28, *Minist. Agric. Lond.*, p. 2. Use of a derris dust of not less than 0.2 per cent. rotenone content valuable means of reducing the numbers of weevils.

Pea and Bean Weevils. *Adv. Leafl. No.* 61, *Minist. Agric. Lond.*, p. 2. Derris dust has not given satisfactory results on a field scale.

Derris Root Infusion for Sucking and Biting Lice of Mammals. By R. B. Gapuz. *Philipp. J. Anim. Indust.*, 1941, **8**, No. 4, 389-393. (*Exp. Sta. Rec.*, 1942, **86**, No. 4, 510.)

Derris Infusion as a Poultry Dip for Louse Eradication. *Philipp. J. Anim. Industr.*, 1940, **7**, No. 2, 153-161. (*R.A.E.*, 1942, **30**, B, Pt. 3, 35.)

A New Method of Controlling the Head Louse. By J. R. Busvine and P. A. Buxton. *Brit. Med. J.*, 1942, Apr. 11, 464-466. Includes recommendation of derris cream (1 per cent. rotenone) as highly effective.

Hoe kunnen wij onze ongecultiveerde concessies productief maken ? By M. J. Dijkman. *Bergcultures*, 1941, **15**, No. 49, 1652-1666. Includes brief account of derris in the N.E. Indies and its opportunities on the American market; export figures for 1935-1940 given.

Studies on the Lethal Effects of Insecticides. Part I. Historical Reviews on the Study of Lethal Mechanism of Derris on Insects. By T. Moriyama. *Formosan Agric. Rev.*, 1941, **37**, No. 4, 24. (*R.A.E.*, 1942, **30**, A, Pt. 4, 216.)

Lonchocarpus

Substitute for Derris. *Public Ledger*, 1942, No. 32865, p. 4. Lonchocarpus being used and available in limited quantity.

Lonchocarpus, subgenus *Phacelanthus* Pittier, in Brazilian Amazonia. By A. Ducke. *Trop. Woods*, 1942, No. 69, 2-7.

PYRETHRIN-CONTAINING MATERIALS

Pyrethrum Analysis: Study of the Seil Method *versus* the Mercury Reduction Method for Determination of Pyrethrins. By G. J. Hartz, P. A. Hendrickson and D. G. Moyer. *Soap*, 1941, **17**, No. 12, 123, 125, 127. (*Brit. Chem. Absts.*, 1942, B, III, 70.)

Pyrethrum Analysis. The Effect of Certain Aliphatic Thiocyanates in the Determination of Pyrethrin I in Mineral Oil Extracts by the Mercury Reduction Method. By J. J. T. Graham. *Soap*, 1942, **18**, No. 4, 101, 105.

The Effect of Storage Conditions on the Toxicity of Pyrethrum Extract. By Z. K. Bogatova. *Bull. Plant Protection, U.S.S.R.*, 1941, No. 1, 69-70. (*Amer. Chem. Absts.*, 1942, **36**, No. 7, 2075.)

Corn Earworm (*Heliothis armigera*). *Picture Sheet No.* 11, *Bur. Entomol. Plant Quarantine, U.S. Dep. Agric.*, 1941. Injections of pyrethrum-in-oil into tip of ear advised.

The Corn Earworm, *Heliothis armigera* Hubner, and Its Control on Sweet Corn. By B. B. Pepper. *Circ. No.* 413, *New Jersey Agric. Exp. Sta.*, 1941. (*Amer. Chem. Absts.*, 1942, **36**, No. 8, 2367.) Pyrethrum extract effective.

The Crusader Bug (*Mietis profana*). *Agric. Gaz. N.S.W.*, 1942, **53**, 37-38. Control obtained by kerosene-pyrethrum emulsion.

Results on Testing Pyrethrum and Soda in Combating *Myzus persicæ* Sulz. By Y. Y. Skalov and A. V. Zagorovskii. *Tabak*, 1940, **10**, No. 6, 48-51. (*Amer. Chem. Absts.*, 1942, **36**, No. 7, 2075.)

The Time of Application of a Bordeaux-pyrethrum Spray to Cranberries. By R. B. Wilcox. *Proc. Amer. Cranberry Growers' Assoc.*, 1941, **71,** 21-22. (*Amer. Chem. Absts.*, 1942, **36,** No. 5, 1431.)

A Progress Report on Investigations of Insects affecting Sugar Beets grown for Seed in Arizona and New Mexico. By O. A. Hills and V. E. Romney *U.S. Dep. Agric., Bur. Entomol. Plant Quarantine,* E.—552, 1941. (*Amer. Chem. Absts.*, 1942, **36,** No. 5, 1429.) Plants injured by a pyrethrum-in-oil spray.

Roach Testing. A Progress Report Describing a New Method of Testing Roach Sprays. By E. R. McGovran and J. H. Fales. *Soap,* 1942, **18,** No. 3, 101-107, 117. Describes a method of testing direct sprays of contact insecticides (pyrethrum sprays) against the German cockroach (*Blatella germanica*).

Pyrethrum *v.* Roaches. Part 1. By F. L. Campbell. *Soap,* 1942, **18,** No. 5, 90-93, 103-105.

The Comparative Value of Phenothiazine, Paradichlorbenzene, Tetralin, Trichlorethylene and Pyrethrum Extracts as Mosquito Larvicides. By J. H. Jordan and W. J. Silvey. *Chin. Med. J.*, 1941, **60,** No. 1, 66-72. (*R.A.E.*, 1942, **30,** B, Pt. 5, 79-80.)

Insect Pests. *Agric. Gaz., N.S.W.*, 1941, **52,** Pt. 5, 277-280. Pyrethrum found useful in controlling larvæ of *Listroderes obliquus* and the beetle *Monolepta rosea*; nicotine sulphate for mites.

Pyrethrum Dusts for the Control of the Apple Redbug. By R. W. Dean. *Bull. No.* 698, *New York St. Agric. Exp. Sta.*, 1942, p. 10. Pyrethrum when applied as a dust has given better control than when used as a spray and has been more consistently effective than nicotine sulphate in either spray or dust form.

Pyrethrum Powder for Insects. *Frms'. Wkly., S. Afr.*, 1942, **63,** Ap. 29, 405.

Insecticides Against Bed-bugs in Shelters. Recommendations by a Committee of the Medical Research Council. *Brit. Med. J.*, 1942, No. 4231, 195. (*R.A.E.*, 1942, **30,** B, Pt. 4, 55.) Pyrethrins in kerosene satisfactory.

Bedbug Insecticide. Pyrethrum extract with other ingredients including citronella oil in a mineral oil; pyrethrum may be mixed with rotenone. *Soap,* 1942, **18,** No. 2, 111.

The Penetration of Pyrethrum through the Cuticle of the Tick *Ornithodorus moubata* Murray. By G. G. Robinson. *Parasitology,* 1942, **34,** No. 1, 113.

Modern Methods for the Control of Mosquitoes and Malaria. Part 1. By G. H. E. Hopkins. *E. Afr. Agric. J.*, 1942, **7,** 212-219. Reference to the value of spraying with pyrethrum extract to reduce danger of malaria.

The Entomology of Commerce. Insect Pests and their Control. By J. W. Munro. *Analyst,* 1942, **67,** 155-159. Refers to the effectiveness of pyrethrum-kerosene as a warehouse spray against *Plodia interpunctella.*

Insecticidal Principle in Smoke from Burning Insect (Pyrethrum) Powder. By M. Nagasse. *J. Agric. Chem. Soc., Japan,* 1941, **17,** 495-502. (*Brit. Chem. and Phys. Abstr.*, 1942, BIII, 149.)

Kenya and the Story of its Newly Established Pyrethrum Industry. By E. W. Bennett. *Soap,* 1942, **18,** No. 3, 88-89, 92.

Estudo das flores de piretro cultivado no Rio Grande do Sul. By W. Mohr. *Rev. Quim. Industr., Brazil,* 1942, **11,** No. 119, 16-22. Study of pyrethrum flowers grown in this district of Brazil.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Insecticidal Efficiency of Some Oils of Plant Origin. By A. W. Cressman and L. H. Dawsey. *Tech. Bull. No.* 801, *U.S. Dep. Agric.*, 1942. Maize, cottonseed, peanut, coconut, orange and pine oil were compared with a refined petroleum oil.

Pests of Sub-tropical Cultures and Control Measures against them in Taluish (Azerbaijan). By P. A. Veltishehev. *Bull. Plant Prot.*, 1940, No. 1-2, 72-77. (*R.A.E.*, 1942, **30,** A, Pt. 3, 138.) Spray containing an extract of the leaves of *Pterocarya caucasia* gave satisfactory control of all stages of *Paratetranychus citri* on citrus and against *Tæniothrips* on *Aleurites*.

Insecticide from Patchouli. *Soap*, 1942, **18**, No. 3, 117.

The Insecticidal and Larvicidal Action of the Essential Oils of *Ocimum basilicum* Linn. and *O. sanctum* Linn. By R. N. Chopra, D. N. Roy and S. M. Ghosh. *J. Malaria Inst. India*, 1941, **4**, 109-112. (*Amer. Chem. Absts.*, 1942, **36**, No. 4, 1111.)

Insecticide from Prickly Ash (*Zanthoxylum clava-herculis* L.). By F. B. LaForge, H. L. Haller and W. N. Sullivan. *J. Amer. Chem. Soc.*, 1942, **64**, 187. (Abst. in *Soap*, 1942, **18**, No. 4, 107.)

Improves Castor Insecticides. *Soap*, 1942, **18**, No. 4, 113. Castor-derived product reported to be satisfactory in the control of scale insects and several species of spider in Florida citrus groves and New England apples orchards.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

AMERICAN COTTON HANDBOOK. By G. R. Merrill, A. R. Macormac and H. R. Mauersberger. Pp. xx + 1024, $7\frac{3}{4} \times 5\frac{1}{2}$. (New York: American Cotton Handbook Co., 1941.) Price in U.S. and Canada $4.80; in other countries $6.00.

The object of this treatise is to give an account of the entire American cotton industry from the preparation of the soil to the marketing of the manufactured article. The three authors mentioned are responsible for the bulk of the work, but seven other experts have contributed chapters on their own special subjects. The book is therefore authoritative as well as complete.

Its contents are divided into 23 chapters, dealing with such subjects as the Historical Background of the American Cotton Industry; Economic and Statistical Background; The Cotton Plant, Its Cultivation and Varieties; Ginning, Classing and Marketing; Opening and Picking Operations; Carding and Combing; Drawing and Roving; Spinning of Cotton Yarns; Winding and Twisting; Manufacture of Sewing Thread and Handwork Cottons; Spooling, Warping and Slashing; Weaving and Designing; Manufacture of Knitgoods; Bleaching, Mercerizing and Dyeing; Printing and Dry Finishing; Manufacture of Terry Fabrics; Physical and Chemical Testing; and Laundering of Cotton Materials. There is a list of books on cotton (unfortunately confined to those written in English), a glossary of cotton terms, and appendixes on the Use of the Statistical Method in Textile Testing (by Prof. E. R. Schwarz) and on the Nomenclature of Dyes.

The book is very well illustrated and forms an excellent up-to-date reference book for all interested in the cotton trade, whether as producers, consumers or students.

TEXTILE TESTING. PHYSICAL, CHEMICAL AND MICROSCOPICAL. By John H. Skinkle. Pp. ix + 267, 8½ × 5½. (New York: Chemical Publishing Co., Inc.; London: Macmillan & Co., Ltd., 1940.) Price 15*s*.

The author of this book is Assistant Professor of Textile Chemistry, Lowell Textile Institute. The most satisfactory sections are those on the physical testing of fibres, yarns and fabrics and on the chemical tests to be applied to determine the nature of fibres and on damage to cellulose fibres, wool and silk. These should be very helpful to both manufacturers and consumers. Part III on microscopical testing is too brief to be of much value, occupying less than 12 pages, plus a few tables giving the microscopical appearance of some starches, hairs, bast fibres, artificial fibres, etc. A large number of references to literature are given throughout the book, and there are numerous illustrations, but it is unfortunate that the paper used is quite unsuitable for the reproduction of half-tone blocks.

AN INTRODUCTION TO THE CHEMISTRY OF CELLULOSE. By J. T. Marsh, M.Sc., F.I.C., F.T.I., and F. C. Wood, Ph.D., F.I.C., F.T.I. Second Edition. Pp. xv + 512, 8½ × 5½. (London: Chapman & Hall, Ltd., 1942.) Price 28*s*.

The first edition of this book was only published in 1938, but since that date many further developments have taken place in cellulose chemistry which have been incorporated in this new edition. It is intended as a relatively simple guide to the younger chemists who are entering those branches of industry which are concerned with cellulose, such as the textile industry, paper-making and rayon manufacture, and admirably meets their requirements. It is essentially a survey of the enormous literature on the subject, the references to which are given in the text as the occasion arises and not in a separate bibliography.

The subject matter is dealt with in five parts, covering respectively the occurrence and general properties of cellulose; its constitution and structure; dispersed cellulose, including mercerising; modified cellulose, i.e. the effects of acids, alkalis and oxidation; and finally the derivatives of cellulose, including the various esters and ethers, as well as rayon manufacture. It will be seen that every aspect of this important subject is covered in the book, which can be thoroughly recommended as an up-to-date treatise, not only for the young research worker, but, as Sir Kenneth Lee says in his Foreword, for those concerned with industrial production and process control who have not the time to read the original literature.

MERCERISING. By J. T. Marsh, M.Sc., F.I.C., F.T.I. Pp. xv + 458, 8½ × 5½. (London: Chapman & Hall, Ltd., 1941.) Price 32*s*.

Nearly 100 years ago Mercer patented his process for the treatment of cotton with caustic soda, and 50 years later Lowe produced the silky lustre of what is now called mercerised cotton by treating the fibre whilst under tension. In the succeeding years more has been written about this aspect of cellulose chemistry than almost any other. Most of this work has been published in the scientific and technical press, and the last complete treatise in English appeared nearly 40 years ago. Mr. Marsh has, therefore, performed a most useful task in compiling the present work, which brings together the results of the latest researches on the subject. After an introduction dealing with the life and work of Mercer and Lowe, the fundamental characters of the cotton hair are discussed, followed by accounts of the mercerising process and description of the plant used, and of the structure of cellulose and the effects of mercerising on that structure. Then follows a discussion of the theoretical aspects of the action of alkali on the fibre and of absorptive capacity. The last part is concerned with more practical matters, including tests for the efficiency of the process and a diagnosis of the faults which may arise in the final product.

Although naturally in the main concerned with the mercerisation of cotton the author also gives an account of the process in relation to rayon and linen.

The book is extremely well produced, with an abundance of illustrations, including a number of microphotographs.

MODERN PAPER-MAKING. By Robert Henderson Clapperton and William Henderson. Second Edition. Pp. xii + 376, 9¾ × 7¼. (Oxford: Basil Blackwell, 1941.) Price 21s.

Considerable progress has been made in the paper-making industry since the first edition of this book appeared in 1928 (see this BULLETIN, 1929, 27, 267). Machinery has been improved and new processes introduced, and all the most important of these changes are reflected in the new edition. For example, the description of the Delthirna Patent Sizing Process has been replaced by an account of the Bewoid Sizing Process and particulars have been added of centrifugal cleaning machines, the sliceless flow box, suction presses, felt conditioners, new steaming systems, and so on. The description of wood pulp has been greatly expanded and improved (this has been contributed by Dr. Bates), whilst the chapter on the manufacture of newsprint has been entirely re-written by Mr. G. F. Underhay. A brief account is now given of paper conditioning, and new methods and appliances used in the testing of paper are dealt with. The book continues to be very well illustrated, most of the illustrations in the first edition being now replaced by new ones.

The chapter on the utilisation of bamboo for paper-making, based on Raitt's researches, which appeared in the last edition, has been omitted, but in the meantime Mr. Raitt has himself published a much fuller account of his work in "The Digestion of

Grasses and Bamboo for Paper-Making " (1931). The short chapter on kraft paper and blotting paper has also been left out which seems rather unfortunate. One would expect to find in these days in a book on modern paper-making some account of the method of re-using printed paper and of de-inking, but this omission is possibly explained by the fact that the revision of the book was almost completed when war broke out and delayed publication.

On the whole the book is an improvement on the last edition, and should continue to be of great value to students and mill workers generally. The only way in which it suffers in comparison is in the absence of an index, which makes reference to its contents extremely difficult.

THE VITAMINS. A Symposium arranged under the auspices of the Council on Pharmacy and Chemistry and the Council on Foods of the American Medical Association. Pp. 637, 8½ × 5½. (Chicago: American Medical Association, 1939.) Price $1.50.

This volume first issued by the American Medical Association in 1939, has been reprinted and distributed by Messrs. Mead Johnson and Company. It consists of a series of some 30 papers by well-known authorities in the United States, each giving a survey of recent literature on the subjects dealt with. For example, the first paper on " The Chemistry of Vitamin A and Substances having a Vitamin A Effect," by Prof. L. S. Palmer of the University of Minnesota, discusses some three dozen papers published between 1930 and 1938, whilst one on " The Pharmacology and Therapeutics of Vitamin A," by Prof. S. W. Clausen of the University of Rochester, contains well over 200 references. Different aspects of Vitamin A, as well as of B, C, D and E, are the subjects of other papers, and there is also one on miscellaneous growth factors, Vitamins K and P and other less well known topics.

Altogether this volume should prove most valuable to medical workers, nutritionists and others interested in vitamins, who will find in it a summary of all the most important work published during the period it covers.

INSECT PESTS IN STORED PRODUCTS. By H. Hayhurst, F.I.C., A.M.I.Chem.E. Second Edition. Pp. xii + 108, 8½ × 5½. (London: Chapman & Hall, Ltd., 1942.) Price 15*s.*

The new edition of this work follows closely the lines of the previous edition published in 1940 (see this BULLETIN, 1940, **38**, 458). A few additional pests are described and illustrated, including a new section on the Siphonaptera (fleas), and there is a new list of insects which are parasitic or feed on certain pests. A bibliography occupying some 20 pages has been added, but many of these references relate to insects not dealt with in the text.

MINERAL RESOURCES

ARTICLE

THE SERVICES OF THE IMPERIAL INSTITUTE TO THE MINING INDUSTRY[1]

By Sir Harry Lindsay, K.C.I.E., C.B.E.,
Director of the Imperial Institute

(*Concluded from p.* 155)

Laboratory Investigation Service

The work of our mineral laboratories, which are staffed with assistants who have had many years' experience in specialised mineral investigations, may be roughly classified under three heads: (1) chemical analysis and assay; (2) mineralogical examination; (3) small-scale technical trials. For these purposes we have chemical, assay and mineralogical laboratories with special facilities for carrying out technical trials on raw materials for the manufacture of Portland and hydraulic cements, plasters and ceramic products.

Frequently mineral samples are received from overseas with a request for examination as to their possible utility and commercial value. This often involves more or less complete chemical analyses, as well as appropriate small-scale technical trials. In order to give our inquirers the best service, this laboratory work, which is carried out in close collaboration with the Intelligence Section, may be supplemented by the opinion of trade experts whom we consult when such action seems likely to lead to useful results.

As might be anticipated, a fair proportion of the samples received for examination from Overseas Governments comes from Colonial Departments which are usually less well equipped for specialised examination and analysis of mineral products than are the corresponding Departments in the Dominions. The work required of the Institute by Geological Surveys often forms part of an investigation which they have in hand, and may provide an important link in a chain of geological evidence. An interesting example of this type of our laboratory work is an investigation carried out for the

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[1] A paper submitted for discussion at a meeting of the Institution of Mining and Metallurgy held on 19th February, 1942. The paper and discussions which followed were printed in *Bull. Instn. Min. Metall.*, 1942, Nos. 449-451. This abbreviated text is reprinted by courtesy of the Editor.

Geological Survey of the Federated Malay States in connection with their survey of a region where gold deposits are known to occur. The Survey wished to know if gold occurred in certain igneous rocks of the area and sent us a number of samples for assay. By an adaptation of dry and wet assay methods, including micro-volumetric titration, we were able to prove the presence of minute quantities of gold in a number of the samples, the smallest amount definitely determined being 0·14 grain per ton, a refinement seldom achieved in ordinary assaying practice. The method devised was considered valuable by the Geological Survey, who now propose to continue the investigation on the lines suggested.

Laboratory work may also play a useful part in the economics of the mining industry. As a case in point, our laboratories, at the request of the Director of the Geological Survey, investigated recently the behaviour of Gold Coast bauxites on calcination. A lengthy series of calcination and autoclave digestion experiments was carried out in order to ascertain the optimum time and temperature of calcination so as to ensure the maximum loss of water whilst leaving the bauxite still amenable to the Bayer process for the extraction of alumina by caustic soda solution under pressure. The results obtained showed that a reduction in weight of 25 per cent. could be effected by calcination at 400° C. without appreciably lessening the solubility of the alumina.

An example of purely analytical work, as distinct from the investigations just mentioned, is afforded by the series of chemical analyses made at the Institute in the preliminary stages of the development of the extensive Sierra Leone iron ore deposits which had already attained an annual export of nearly one million tons just before the war, and are of such vital importance at the present time.

In addition to the direct benefit that may be derived by the mining industry from these laboratory investigations, an indirect benefit may result from the investigation and technical trials of materials considered suitable for the production of cement, lime, bricks and tiles, and other products essential for the improvement of local housing conditions.

Some years ago it was our work on cement-making materials from the Central Provinces of India which laid the foundations for what I think was the first large factory in India (the Katni Cement & Industrial Co.) for the manufacture of high-grade Portland cement. The results obtained in our laboratories after prolonged investigations into the possibility of making Portland cement from calcareous materials occurring in the bed of Lake Malombe, Nyasaland, were very promising, and only local financial considerations prevented the establishment of a works. Projects for the manufacture of cement in Ceylon and Trinidad now under consideration are also based on our preliminary investigations and technical trials of raw materials.

Technical trials of raw materials suitable for the local manufacture of hydraulic cement have also been carried out in our cement materials laboratory for many years past. This variety of cement is of special interest as it can be manufactured with the aid of fairly simple plant and can be used for small structures where great strength is not required.

In our ceramic laboratory we have also carried out extensive technical trials on clays from many Colonies for making bricks, tiles and refractory ware for local use.

Adequate supplies of water for both industrial and domestic purposes are of considerable importance to the development of a district, and the Institute has been able to assist in the valuable water-boring work carried out by the Governments in Nyasaland, Southern Rhodesia and Somaliland by making complete analyses of the dissolved solids in a large number of samples from each Colony.

Transport is of vital importance to the exploitation of mineral deposits and for this reason we have taken considerable interest in fuel for use in producer-gas driven vehicles in relatively undeveloped areas. Samples of charcoal made from many and various woods have been analysed in our laboratories, and we have also had practical trials carried out with a view to determining their suitability for the purpose.

For reference purposes we maintain a catalogued collection of samples of all the minerals we have examined since about 1904, including many thousands of rocks and minerals collected by the officers of the Mineralogical Surveys, which were conducted some years ago in Ceylon, Nigeria, Nyasaland and Kenya under the auspices of the Imperial Institute. These samples have often proved of service to mining experts and others who were interested in the possible development of particular minerals in the countries concerned. Mention of these Surveys reminds me of a piece of now ancient history, i.e. that the credit for the location of the only black coal deposits being worked in West Africa is due to officers of the Institute, who were also responsible for much of the early work in locating the tin deposits in the Northern Provinces of Nigeria.

We also maintain a small but useful reference collection of economic minerals, started some years ago at the instigation of the late Professor J. W. Gregory, which we are gradually but slowly extending.

Last, but by no means least, of the various services available to the mining industry at the Imperial Institute, is that connected with mining law.

Mining Law Service

It is, I am sure, unnecessary for me to stress the important influence which a country's mining laws, good or bad, may have on the prosperity and development of its mining industry. The terms upon which would-be prospectors can obtain the necessary rights to explore terrain, the security of tenure provided, the size of areas to be allocated for prospecting or mining any particular mineral, the provision of adequate guarantees to ensure proper exploitation, and the amounts of royalties, export duties or other forms of taxation levied on output, are all matters which may affect the success of a mining venture.

Since the amalgamation of the Imperial Mineral Resources Bureau with the Imperial Institute in 1925, the Institute has taken considerable interest in the technical aspects of mining law. I regret that in 1938 for financial reasons we had to dispense with the services of our Legal Consultant to the Advisory Council on Minerals, and to discontinue the publication of our volumes on Empire Mining Law. Nevertheless, we have retained our Mining Law Technical Committee, which, under the chairmanship of Mr. W. Forster Brown, C.B.E., Chief Mineral Inspector to the Commissioner of Crown Lands and the Duchy of Cornwall, comprises within its nine members, five of whom belong to your Institution, authorities on mining law and mineral development overseas as well as representatives of certain of the Dominions.

The services of this Committee are frequently enlisted when the Institute is called upon by the Dominions or Colonial Offices or Mines Departments overseas, to advise on questions affecting mining legislation and development. By virtue of the wide range of interests represented, it maintains a good balance between the natural desire of Overseas Governments to obtain revenue from mining ventures and the need for reasonable encouragement to financial groups or individuals to spend money, often considerable sums, on prospecting and developing mineral deposits.

It is not possible here to describe in detail many of the interesting problems which have been submitted to the Committee in recent years, but perhaps a few examples will serve to illustrate the range of subjects with which it has dealt in an advisory capacity.

Several years ago when the Government of Newfoundland was considering an application for the issue of an exclusive prospecting licence over an area of 4,000 sq. miles in a rather inaccessible and inhospitable part of Labrador, the Dominions Office sought the advice of our Committee. The draft terms both for the exclusive prospecting licence and for the subsequent issue of mining leases for workable deposits located by the concessionnaires were considered in detail by the Committee, which made a number of recommendations. These recommendations were very comprehensive and included the areas to be allocated for mining specific minerals, the amount and basis of calculation of royalties, and safeguards to ensure adequate prospecting. The suggestions put forward by our Committee were approved; the applicants received their licence and have since made considerable progress in the examination and development of some deposits in this vast area, concerning which very little information was previously available.

On other occasions our Mining Law Technical Committee has considered draft mining ordinances relating to Kenya, Tanganyika, Uganda, Sierra Leone, Somaliland, Bechuanaland and Fiji.

It often happens that a mining ordinance contains provisions for levying royalty on certain minerals which at the time of its enactment were not being worked in the country concerned. When the opening up of the deposits becomes possible it may be that the mineral in question is expensive to produce or difficult to market and the imposition of the prescribed royalty may seriously hamper development or marketing. The advice of our Committee has been sought in several such cases, in some of which they have been able to recommend a reduction or suspension of the royalty, or the granting of other facilities such as reduced freight on Government-owned railways until the mineral has secured an established market. A recent example which occurs to me is that of chromite in Sierra Leone.

The advantage of retaining control of the refining of copper produced within the Empire needs no stressing in these times, particularly when the output is on such a large scale as that developed in Northern Rhodesia in recent years. It is, I think, to the credit both of our Mining Law and Copper Committees that in 1929, when the Northern Rhodesia copper industry was in its infancy, they foresaw future developments, and at the suggestion of Dr. C. B. Kingston took joint action to urge upon the Home and Overseas Governments the desirability of adopting measures to ensure that the smelting and refining of the ore should be carried out and retained under British control. As you are doubtless aware, this suggestion was duly implemented and to-day we see Northern Rhodesia contributing to our war effort large quantities of blister and refined copper, in addition to important quantities of a cobalt-iron alloy obtained as a by-product.

The mention of copper smelting in Northern Rhodesia reminds me that this industry has not been without its troubles, one of which was the possibility of injunctions being obtained by local landholders on account of alleged damage caused by smoke or smelter fumes. The Colonial Office sought the advice of the Institute on this question, and our Mining Law Technical Committee was able to offer suggestions both as regards methods for compensating the holders of land in the vicinity of the smelter and for legislation to debar claims in respect of land leased in the future.

The Institute has always taken a close interest in the production of alluvial diamonds in Sierra Leone, which now amounts to between 700,000 and 900,000 metric carats per year, and the terms upon which the exclusive licence to prospect and work the deposits was granted received much consideration from our Committee before the licence became operative.

The Institute figures in the Customs Tariff Ordinance of the Gold Coast which provides that the value of parcels of diamonds for the purpose of calculating the *ad valorem* export duty shall be assessed by a valuer appointed by the Government, but that, in the event of a dispute arising between the producer and the Government, the matter shall be submitted to the arbitration of a person agreed upon by the Government and the exporter. In the event of the two parties failing to reach an agreement on the person to be appointed as arbitrator, the nomination shall be made by the Advisory Council on Minerals of the Imperial Institute. Such a case recently arose and I do not think I am divulging official secrets if I state that the verdict of the Institute's nominee, a well-known diamond expert, was one with which the mining company had no cause to be dissatisfied.

I must not omit to mention that we endeavour to maintain at the Institute an up-to-date collection of the mining ordinances and regulations in force throughout the Empire ; probably the only one in this country available for consultation by the public. This collection has been of great value in dealing with inquiries from Overseas Governments, not only for comparing the legislation in force in various Empire countries but also as a guide in framing new mining laws and regulations.

Members of the mining profession sometimes require data which will enable them to compare readily the conditions prevailing in various parts of the Empire in regard to certain aspects of mining legislation, and the Institute endeavoured to cater for at least one aspect of this need when it compiled and published in 1936 its volume of *Mining Royalties and Rents in the British Empire.* The preparation of a new edition of this volume was commenced in 1939, but the work was suspended owing to demands made upon our services by various war-time Ministries. A smaller effort, but one which may prove equally useful, is a 37-page article published in a recent issue (No. 3 of 1941) of our Quarterly Bulletin and entitled "Government Assistance to the Empire Mining Industry." This article summarises details of the many forms of Government assistance available, such as those afforded by Geological Surveys, Departments of Mines, Mineral Research Laboratories, loans of cash or equipment to prospectors, Government stamp batteries, bounties on production, grants for the improvement of transport facilities, and so on. The preliminary draft was prepared at the request of the Non-Ferrous Ores Committee of the Ministry of Supply, but as it seemed likely to be of some general interest to the mining industry, it was amended, after consultation with various Overseas Departments, and published.

CONCLUSIONS

I feel sure that you will agree that an organisation, which has proved its value as an aid to the economic development of our overseas Empire, should not rest on its oars. We at the Institute have ideas as to several directions in which we might usefully improve and expand our peace-time activities, provided that the necessary financial support is forthcoming. Although in recent years we have been more fortunate than previously in regard to finance, our funds are only sufficient for immediate needs and do not permit of expansion.

We should like to double our present minerals intelligence staff of eight officers so as to be able to implement fully our scheme for a quinquennial revision of each of our mineral monographs; to deal adequately with the ever-increasing volume of day-to-day inquiries concerning mineral occurrences and technology; and, in addition, to permit of our sending a few of our staff on overseas visits to collect up-to-date information at first hand. This would be "next best" to the ultimate adoption of the scheme put forward in 1927 by a distinguished member of our Advisory Council on Minerals, Sir Thomas Holland, at that time your President, for a complete co-ordinated review of the mineral resources of the Empire. This scheme received the approval of your Institution and was placed before the Second (Triennial) Empire Mining and Metallurgical Congress, but has not yet received effect.

From overseas Mining and Geological departments, from Trade and Consular Officers, and from the mining industry generally, we should like to receive more early and first-hand reports of impending developments than we get at present. This is particularly necessary in regard to the minor and less-known minerals which are daily finding more and more applications in industry. I know that in this domain our chief difficulty will be to persuade the individual owner or manager within your industry to furnish information about his own developments and output, which is to be pooled for the benefit of all. But such co-operative effort is bread cast upon the waters; and the return would come to you, not "after many days," but as promptly as we could tabulate and issue it!

The idea has been mooted from time to time of the need for an Annual Mining Handbook of the British Empire somewhat on the lines of the Minerals Year Book produced by the United States Department of Mines for that country. We should like to attempt the production of such a volume, but if it were intended to challenge comparison with the U.S. document, it would be necessary for certain countries, notably Great Britain, to furnish much more detailed statistics than are at present available to illustrate the consumption of specific minerals by specific industries and for specific purposes.

And finally we should like to see the Institute officially recognised as the home of the Colonial Geological Surveys where officers on leave could investigate any special problems in which they are interested. The advantages of such recognition, and of the closer contacts thus secured, must surely be obvious to all concerned.

DISCUSSION

Dr. J. G. Lawn said that Sir Harry Lindsay had expressed some hesitation about undertaking the task of preparing this most interesting paper. His hesitation was on the ground of expediency, but he might much better have excused himself on the ground of the heavy work which the Institute was called upon to do in connection with the war effort. It would have been reasonable to have said that he and his staff had more important things to do than to prepare a paper of this kind at the present juncture.

But on this question of expediency it was very opportune that this paper should have been written now and circulated to members of the Institution in all parts of the world. After all, the Government considered that the question of reconstruction after the war was of such importance that some of the best brains available had been allocated to that work even in the midst of the present turmoil. The mineral industry would have its part to play in reconstruction, and he was quite sure that the Imperial Institute would take its full share in helping the industry.

The problems that would arise could only dimly be foreseen, but it was quite clear that the wider the knowledge available to the Institute the more effective the help that could be obtained from its services. He was entirely in sympathy with Sir Harry's remarks deprecating the tendency to secrecy and conservatism.

He had been always keenly interested in the work of the Institute on obscure minerals—minerals not frequently met with in every-day experience. The close contact between the Institute and the actual users of some of these minerals was invaluable. Often some slight difference in the chemical composition, or even in the physical condition, of a mineral might destroy its value or, on the other hand, might make it available for particular purposes, and there was no better way of getting information on the subject than by going to the people who used it. That contact had been cultivated by the Institute and was appreciated by the buyers of these minerals as well as by the sellers, and was obviously of the greatest value.

Every mining man was familiar with the monographs of the Institute. They contained the very latest information set out in a very clear and systematic way. They followed a sequence in dealing with a particular subject which made them easy for reference. The statistics to his mind were wonderful when the difficulties with which the Institute was faced in collecting them were considered. There had always been a shortage of money and consequent difficulty in employing an adequate staff, and what had been achieved certainly redounded to the Institute's credit.

The knowledge that the Institute possessed on mining law had been used very effectively in helping various authorities. When a mining law was being prepared for some colony and the legal assistance available was not broadly informed, it could be well understood that inadvertently things might creep in which would act detrimentally to the development of mining and to anyone who was trying to carry out work there. In that respect the Institute, looking at the matter from both sides—with a view to helping the colony itself and also keeping in mind the commercial interests which might be involved, as well as the technical interests of the engineer who would have to carry on any mining operations which might be started there—had been able to render substantial help to the Colonial Office. There again contact had been established for many years under conditions of mutual confidence.

The author had said that he would like to see the laboratories at the Institute used as a kind of " home " by the members of the Geological Surveys from the Colonies who came on leave to this country. That struck him as a very natural arrangement, and it was to be hoped that it would eventuate.

Their thanks were due to Sir Harry Lindsay for this important and interesting paper, which he hoped would be widely read by members abroad in many countries, and he trusted that members would be stimulated not only to avail themselves of the services of the Institute, but also to put their special knowledge into the common pool.

Sir William Larke (Chairman of the Advisory Council on Mineral Resources, Imperial Institute) said that he was grateful for the invitation to speak at a meeting of an Institution of which he was not qualified to be a member.

It was a remarkable thing that the Imperial Institute with its budget of £48,000 per annum should be able to do anything like the work it did. In his opinion—and he had had a good deal of association with the mineral aspects of the Empire in other connections—if the £48,000 were spent on the mineral department alone it would not be excessive having regard to the importance of that section of our imperial resources.

The Mineralogical Committee (of which he was Chairman) of the Imperial Economic Committee, which had the task of preparing the data for the Imperial Conference at Ottawa, made a valiant effort to obtain unified statistics from the different Dominions and Colonies on the same basis of definition, so that it would be known what they were talking about when they came to correlate the statistics of the Empire as a whole. All the geological offices in the Dominions and Colonies were circulated; returns were received from some, but no replies from many, and such replies as were received were not on the same basis. What did rather worry him was that there did not seem to be an appreciation on the part of the officers concerned that unification was really necessary.

He had had a good deal of experience in trying to overcome the individualistic attitude that secrecy was really of profit to anybody. He had succeeded in a measure in one or two industries, but it required the enthusiasm and effort of a crusader. It would prove essential for the economic recovery of the Empire itself that such data should be forthcoming from the several parts of the Empire as would enable some Empire Conference to propound a reconstruction policy based on a proper appreciation of economic interdependence and the best methods of developing and exploiting the natural resources with which Providence had endowed them to the advantage of all. He trusted they would be able to convince the geological officers and services to that effect.

Since Sir Harry Lindsay became Director he had made visits to most of the Dominions and had secured increasing financial support and technical appreciation of the work of the Imperial Institute, but, really, for the greatest Empire the world had ever seen, it was pitiful that the Institute should have an income and expenditure of only £48,000 a year. Many industrial associations spent more than that. Could that sum be said really to represent the magnitude of appreciation of our imperial responsibilities in relation to our economic resources?

Finally, he strongly supported the suggestion that the Imperial Institute should be the rallying point for the geological surveys and offices for the Empire as a whole.

Mr. Thomas Pryor said that many members of the Institution of Mining and Metallurgy had had reason to be grateful for the excellent monographs and statistical summaries published by the Imperial Institute, but he doubted whether the majority of the Institution members, and especially those normally resident abroad, were aware of the full range of the assistance which the Imperial Institute was prepared to render to enquirers. He hoped that when their *Bulletin* went abroad to mining fields throughout the world it would not only be read with interest but would cause practical results in increased use of the Imperial Institute by mining engineers.

At the end of his address Sir Harry Lindsay had referred to the desire of the Imperial Institute to receive more first-hand information regarding impending developments in the mining of minor metals and certain non-metallic minerals. The Institution of Mining and Metallurgy also should do its utmost to encourage the receipt of papers on such matters. The speaker had expressed regret on previous occasions that their papers were too much concerned with the major metals—gold, copper, lead, zinc and tin. It was true that from the technical point of view the mining of many of the non-metallic minerals was simple as compared with the intricate operations of deep metal-mining, but it was the duty of the Institution of Mining and Metallurgy to foster the advancement of the science and practice of mining in respect of all minerals other than coal.

An extremely important activity of the Imperial Institute was its mining law service, which had included the publication of a volume on mining royalties and rents in the British Empire, and the publication, in the autumn of last year, of a special article on Government assistance to the Empire mining industry. The opening sentence of the article was: "The extent to which the various Governments of the Empire assist their mining industries in one way or another is not generally realised or appreciated." That was true, but the article, though instructive, did not tell the whole story. His personal view was that the converse of the extract he had just quoted would be also true: "The extent to which the various Governments of the Empire *hamper* their mining industries in one way or another is not generally realised or appreciated." There was a real need for the better information of Government on this aspect of the matter.

He entirely agreed with those other speakers who had stressed the need for the abandonment of secrecy in technical matters. They would, however, never get to the bottom of the factors adversely affecting the mining industry, unless companies would permit their officers to make public the information, at present frequently regarded as confidential, which would show how greatly mining was hindered by difficulties and restrictions imposed by Governments.

Dr. S. W. Smith said that he had read this paper with the greatest interest as one who had realised for many years the importance of an organisation of this kind. The Director had said that despite the fifty years of its existence the Institute was not nearly as well known as it should be. He had that feeling himself, because, as a nominal member of one of those Committees to whose advice and assistance the Director had paid such warm tribute, he had wondered whether full use was being made, not of any services of his own, but of those of the other members of the Institution of Mining and Metallurgy. He hoped it might be so, as their knowledge of the "underworld" was, like Mr. Weller's knowledge of London, both "extensive and peculiar."

The publications of the Institute were excellent. He himself wished to acknowledge his indebtedness to Mr. Johnstone for his recent Streatfeild Lecture, which had been of great value to him in attempting to summarise the Empire's mineral resources, from the point of view of the metallurgist, for the benefit of the students of the Royal School of Mines. One remembered the efforts of Sir Thomas Holland, and of others, both here and in America, to promote discussions relating to mineral resources, and one could not but feel that the technical implications of these valuable discussions had not been adequately realised.

With regard to laboratory work, one did realise the limitations to which laboratory investigations were necessarily restricted in an organisation of this kind. What the Director had said about the facilities available in the Dominions was, of course, quite true. Those who had seen what was being done at Ottawa by the Ministry of Mines, and also on the Rand by the Chamber of Mines and the various mining groups, would realise what all this meant. It would be of immense value to have such facilities, even to a limited extent, in this country. He desired to make one small constructive suggestion. He thought that one of their many failings in the past had been that they had not paid sufficient attention to the vital necessity of passing on to the student of technology the knowledge and experience they had themselves acquired, and, moreover, of passing it on to him at quite an early stage in his career. By introducing him to the sources of information and the administrative machinery by which the professions are sustained, he could make fuller use of such facilities when his turn came to shoulder responsibility in his profession. He suggested, therefore, that before students of mining and metallurgy in this country finished their courses and passed out into the field of action they should be shown at the Imperial Institute the services which would be available to them.

Mr. H. M. Ridge drew attention to the unfortunate effects of that policy of parsimony which followed from the use of the Geddes axe, when the expenditure for the collection of information from various parts of the Empire regarding its mineral resources was cut down. That was an episode which belonged to the past, but he thought their efforts should be directed to preventing the exercise of a similar axe at the present time or in the future.

A further constructive suggestion he wished to put forward concerned mineral and metal statistics. During the last war many people experienced difficulties in obtaining sufficient information regarding the production that was taking place. The result was the formation of the Imperial Mineral Resources Bureau immediately after the armistice, and this work was afterwards taken over by the Imperial Institute. Certain Government departments had found it necessary to proceed with the collection of statistical information, and although it would obviously be undesirable to publish that information very quickly, it might be done at the end of a certain period. Surely it would be possible at the present time to publish the data, say, up to the end of 1940—in other words, over a year after the event. That would contribute largely in assisting to provide for future requirements.

During the present war people should be able to realise how the production in certain areas was affected, and the fact that some minerals and metals were no longer available. If the companies concerned in the Empire and other parts of the world awakened to the need for various minerals and metals, it would largely contribute to the national effort. He asked whether Sir Harry Lindsay would endeavour to get those in authority to agree to the publication of statistics, say, twelve or fifteen months after the period to which they applied.

Sir Edmund Teale said that his own association with the Institute dated back for well over thirty years. At that time he was starting work in Nigeria on mineral exploration as an officer of the Mineral Survey. The officers of that and other Surveys came back at frequent intervals to the Institute and carried out their examinations in its laboratories. Thereby they came in close contact with the experts in the various branches. This proved very valuable, and it was largely due to the success of those mineral surveys that the work was extended to a geological survey in nearly all the colonial possessions and dependencies. But the Geological Surveys then came under the direct control of the local administration, and when that change came about the officers concerned no longer returned to the Institute to carry out their work, and so a most useful contact was lost. At the same time, the Institute continued to offer all its facilities for assay, analysis, examination and advice. Local laboratories were usually set up to cover all the ordinary identifications and examinations. There still remained some technical enquiries and investigations that were beyond their scope and the assistance of the Institute was gladly accepted for this work.

Sir Harry had mentioned his desire that a closer contact should be re-established with geologists when they came back to the home country, and he fully endorsed that view. If it was possible to bring about again that closer association with geologists on leave so that they could at any rate make use of the opportunities of the Institute's laboratories and in other ways carry forward their special lines of work, it would be no small imperial service.

The Institute was working up to the limit at present, but it was quite clear that scope for additional work was there if funds could be supplied. There was one respect in which the local colonial surveys and the Mines Departments might perhaps help a little with regard to information which was so often liable to be lost or pigeonholed. Many mines and sometimes concessions, after a considerable amount of work had been done, were abandoned for various reasons. They still might have great potentialities, but it had not been possible to open them up. Conditions, however, changed, and it then became important to review the situation with regard to these mines and concessions. Sometimes quite a lot of work had been done upon them, and in most cases the Government endeavoured to secure that information which was filed as confidential for as long as the company or concession held the interest. Afterwards the information was liable to be lost sight of altogether, and therefore he thought that something might be done locally to see that that information was suitably recorded and indexed. These references might very well be sent to the Imperial Institute to be added to its records, where they would thus secure a wider accessibility for useful reference as occasion arose.

The very valuable work along educational lines which the Institute had been carrying out in its exhibition galleries and its cinema was recognised. He would like to see added to that valuable record as complete a library of mining films as possible. There were many opportunities for recording the various conditions of work on mines, the particular processes used, and so on, and although it would not be an easy task, it should be possible to bring together a complete record of mining activities illustrated by films which in the hands of the Institute would form a most valuable means of instruction.

Mr. E. H. Clifford (President of the Institution of Mining and Metallurgy) said that there was a danger of appearing ungracious in making suggestions involving further work by the Imperial Institute, which had to cover such a large field with an annual budget of only £48,000. But Sir Harry Lindsay himself had asked for suggestions and one point which he had raised was a challenge to the Institution of Mining and Metallurgy. It was obvious that the members of the Institution, in the course of their work, became possessed of a great deal more information than could possibly be obtained from Government sources, and this information was really essential for a proper appreciation of the statistical statements relating to any particular metal. While it could not be expected that they would make public every side of their business, there was a great deal of information of this kind which, if published, would be for the general good. With regard to the collection of statistics, uniformity of statement and precise definition were essential.

The Imperial Institute had done valuable work in collecting the mining laws of the Empire and it had also issued an excellent work on mining rents and royalties. Might he make a suggestion that an opportunity be taken to do the same thing in regard to taxation within the Empire? To his mind the mining industry would be dominated for a long time to come by taxation. There was a great variety within the Empire of rates of tax and of methods of assessment. These could not all be right. In fact, some were not in the best interests of the Governments concerned, to say nothing of the interests of the mining industry. He did not suppose that it was within the province of the Institute to comment on the effects of taxation, but a straightforward compilation of the facts would be of immense value to all concerned.

Sir Harry Lindsay, in reply, said that Dr. Lawn, Sir William Larke and Sir Edmund Teale had referred to the desirability of the Institute becoming the recognised centre for the geological surveys of the Empire. It already went half-way towards securing that result in that every month it received, by courtesy of the Colonial Office, lists of the technical officers of the Colonial Governments who were home on leave and thus it was enabled to get into touch with them and encourage them to visit the building, to discuss their problems and exchange information. Before the war the Institute was receiving visits from these officers to the number of twenty or thirty a month. He would like very much to see the position definitely recognised that the Institute was a place of call for all technical and scientific officers of Empire Governments home on leave.

He would like also to see Dr. Smith's suggestion adopted whereby students of mining were encouraged to visit the Imperial Institute to make contact with the officers of the Mineral Resources Intelligence

Department there and to see the mining films in their Cinema and the mineral exhibits in their Galleries. Sir Edmund Teale had mentioned the possibilities of doing more in the way of illustration of mining activities from films, and that was a point which also they had in mind. Quite a large section of their Film Library was given up to the subject of mining activities, so that a programme of such films could easily be put together as required.

Mr. Ridge had referred to the importance of the unification of mineral statistics, and there again he was heartily in agreement with him. It was very important that they should be in a position to undertake these duties, especially as the idea was embodied in a definite reference to the Imperial Institute by the Conference of British Commonwealth Statisticians.

Finally, on the difficult question of taxation within the Empire, to which the President had alluded, the Institute was able to pull its weight in many directions which were not perhaps always recognised and its influence was invariably directed towards such assessments as would result in encouragement rather than discouragement to the industry. The advice of the Mining Law Technical Committee was always available and if the true history of the matter could be written it would be shown that thereby a great deal had been done to facilitate mining enterprise and progress.

CONTRIBUTED REMARKS

Sir Lewis Fermor: I had arranged to be present to hear Sir Harry Lindsay read his paper, but was unfortunately prevented at the last moment. This I much regret, both because I have known the author personally for many years, dating from the far-away days in Calcutta when Sir Harry was Director of Commercial Intelligence to the Government of India, and because I have been a beneficiary at intervals of the activities of the Imperial Institute. The first benefit was a series of analyses of samples and specimens of Indian manganese ores and minerals collected by myself in 1903 and 1904, the results of which have been published in my memoir on the manganese-ore deposits of India (*Memoirs, Geol. Surv. Ind.*, 1909.) Later benefits have been the magnificent series of reports on mineral statistics to which I refer later.

Many will be surprised to learn from Sir Harry's paper, as I am myself, the extent of the development on the mineral side of the activities of the Imperial Institute and their wide scope.

The Imperial Institute is undertaking amongst its duties many tasks that are elsewhere allotted to Geological Survey Departments. There is no objection to this, because many of the Colonial Geological and Mineral Departments have such a small staff that it is advantageous to be able to refer to a central body such as the Imperial Institute where the common problems, mineral, statistical and administrative, can be harmonised and synthesised.

To me the most important activity of the Imperial Institute is the compilation of the world's mineral statistics as presented in the annual Statistical Summaries of the Institute. These summaries confine themselves, however, and perhaps wisely, to statistics of quantity only, of production, exports and imports of minerals, omitting all data of values. These summaries are, of course, based on the official statistics of the various countries, which often give values. In the statement of values practice varies: partly because of the inherent difficulties of uniformity, and partly because some countries, where the raw minerals produced are also worked up into intermediate or finished products, give in their statements the values of these semi-finished or finished products, particularly metals, rather than that of the raw mineral products before smelting; this is due in some cases, I suspect, to a desire to make the total value of mineral production appear as large and important as possible.

Consequently I am heartily in agreement with the sentence in which Sir Harry mentions the desirability of a unified system of recording mining and metallurgical statistics. This applies particularly to values.

An admirable publication of the Imperial Institute is the monograph entitled "Mining Royalties and Rents in the British Empire," issued in 1936. I have found this monograph of the greatest interest, especially for the exposition of the principles governing the levy of royalties.

Other publications of the Imperial Institute deserving special mention are the valuable small monographs on single minerals, which almost render it unnecessary for other would-be authors to produce specialised monographs!

I have written enough to express my sense of the value of the work for the mineral industry undertaken by the Imperial Institute. It is well that this work should be brought to notice periodically. In conclusion, the Director is to be congratulated in having succeeded in securing a staff adequate to enable him to undertake these many activities, although he would naturally like to ask for more.

Mr. Andrew Pearson: After reading Sir Harry Lindsay's comprehensive account of the activities, on the mineral side, of the Imperial Institute, it was with a sense of disappointment that I attended this meeting. This feeling, however, soon changed to one of lively sympathy for an organisation which was obviously doing its best under difficult conditions—an allocation of £48,000 can hardly be termed "imperial," and, as indicated by Sir William Larke in his remarks, is a doleful commentary on our conception of Imperial obligations.

In his interesting introductory remarks Sir Harry Lindsay made reference to the United States Bureau of Mines as being engaged upon similar work.

In the annual report for 1940 by the Director of the Bureau the functions of that organisation are given as:

"To promote safety in the mineral industries, to conserve mineral resources and to conduct investigations on the mining, preparation and utilisation of minerals."

Admittedly some of these functions are, in our case, shared by organisations other than the Imperial Institute, so that comparison is somewhat difficult. Nevertheless, there is a certain amount of parallel effort as is shown by the record of the Technologic Branch, and a glance through the year's activities described in the Director's Report might be of interest. For the year 1940 the Bureau was allotted over 3,000,000 dollars, and of this amount approximately 2,000,000 dollars was required by the Technologic Branch. For the work in hand, and projected, the Director considers that more funds are required. In other words, more than ten times the allocation available for the whole of the work of the Imperial Institute was considered insufficient by the Bureau of Mines in their efforts to conserve, exploit or utilise the domestic mineral wealth of the U.S.A.

It is profitless to criticise without offering something constructive and I would suggest that Sir Harry Lindsay's desire for suggestions for more extensive co-operation should be carefully considered by members of this Institution, whose livelihood more than that of others is dependent upon the mineral industry as a whole and who stand to gain so much by more active development of imperial resources.

The nature and extent of such co-operation appears to me to be a matter for serious deliberation and review for which the present time seems most opportune.

Mr. Philip Rabone: I consider that a great increase in the activities of the Imperial Institute will be not merely desirable but a vital necessity in meeting the needs of the future.

The pattern of the future is outlined in the Atlantic Charter, of which Clauses 4 and 5 cover the economic field. They indicate the probability not only of greater collaboration between nations than has been the case in the past but also of greater activity in trade and industry.

In order to maintain their position in the economic sphere in the years to come, Great Britain and the Empire will need an organisation for developing and controlling their natural resources with much greater powers and funds than are possessed by the Imperial Institute at present. I consider that we shall need a comprehensive Bureau of Raw Materials serving Great Britain and the territories in her charge. I suggest that it could well be modelled on the United States Bureau of Mines, but it must be constituted to include all natural resources and should possess considerable powers of control over the industries concerned. It should exercise a general guidance in the development, production, processing and distribution of the raw or processed materials. Besides collecting and distributing information, it should have facilities for carrying out investigations and research which cannot normally be undertaken by private interests. Finally, it should possess powers to enforce obedience to the moral implications of the Atlantic Charter.

All our energies must be directed at present towards winning the war. When the time comes for planning for the post-war constructive period, I suggest that the Imperial Institute and other Institutions, our own included, interested in the development of natural resources, should immediately get together and formulate a practicable scheme to put before the Government. Some responsible authority will have to take the lead. Without knowing whether the Imperial Institute has any intentions in this matter, I offer three reasons why I think that it is the best body to initiate the scheme : (1) It already possesses a constitution on which the new Bureau could be based ; (2) it has had fifty years experience in the type of work which would be required ; and (3) its efforts have never been directed by selfish interest but always with the motive of real helpfulness on behalf of those whose interests it is designed to serve.

I am certain that, if we do not have a powerful Bureau of Raw Materials to look after our interests in the future, we shall find ourselves falling far behind other countries as an old-fashioned and out-worn nation.

Dr. Wm. Cullen : Sir Harry Lindsay's survey could hardly be improved and it is the best presentation of the subject which has been made to date. I agree with Sir William Larke that the amount of work accomplished by the Institute with its limited staff is little less than wonderful, and that this work is only circumscribed by the entirely inadequate revenue. Less than one-half of this is, I believe, provided by the British Treasury, and I think that our Treasury, the Dominions and the Colonies have conjointly taken a rather parsimonious view of what the Institute stands for and what it is capable of doing. It is or ought to be not only the shop window of our great Empire but the focal point of all other Empire activities, including, as Sir William suggests, the home of the Colonial Geological Surveys. But so long as the University of London retains control of a large proportion of the total space it is difficult to see what more can be done than is being done at present. The Institute is, of course, a semi-governmental undertaking. I personally distrust all governmental activities, for the " dead hand " of the Civil Service can never be altogether excluded, but I certainly do think that it is less in evidence at the Imperial Institute than anywhere else. I know most of the staff and in my opinion they are all most competent—notwithstanding the wholly inadequate salaries which they receive, even as compared with other government departments. But all government scientific officers are badly paid, and this probably accounts for the fact that so few of them belong to Institutions such as our own.

Sir Harry refers to the sources of the revenue and states that all Dominions make grants. It is true that all of them contribute something but the total is not impressive.

That the Institute is not nearly so well known as it should be is easily explained: the Institute does not advertise itself—because it has no money to do so. The members of the staff do not get about as much as they should for the same reason, and papers such as Sir Harry's and Mr. Johnstone's are far too rare. These papers will, I am convinced, do much to dispel ignorance in our own and other circles, but that of itself is not nearly enough.

It is perfectly true that the Institute has gained the confidence of the brokers and consumers, as I can fully testify from first-hand experience. Indeed I sometimes feel ashamed of myself for passing on so many anxious inquirers, but I cannot recall any case where they received a word of discouragement.

Reference is made to the Laboratory Investigation Service and the view is held in some quarters that this should not exist, as it competes with the practice of private consultants, but I have come to the conclusion that, taking the investigations as a whole, they could not be done by any consultants that I know. The work is so specialised that it must be carried out in conjunction with people who have geological and mineralogical knowledge together with past experience of the same kind of work in many parts of the world.

In conclusion, I would like to refer to criticisms of the Institute which have recently appeared in the Press, some of which, however, have nothing to do with the matter of this paper. On the other hand there was just a little truth in them, but without additional revenue I do not see that Sir Harry and his staff can do more than they have done. As Sir William Larke has pointed out, the Director has made himself familiar with the conditions of other parts of the Empire, which is all to the good. I know also that certain members of the staff have got out and about. From all these activities I am sure the Institute has benefited. More of this is required, but it costs money and the shortage of revenue is the real drag on the Institute's activities.

ABSTRACTS AND NOTES

Geological Work in Nigeria.—The following report on the work carried out by his Department during 1941 has been received from the Director of the Geological Survey of Nigeria.

During 1941 the activities of the Department have been very much restricted owing to the lack of staff and materials essential for well sinking.

Gold.—An investigation of that part of the Sokoto Goldfield situated in the Zamfara Valley was started but this was considerably hampered by the lack of reliable topographical maps. In the Province itself sediments of Cretaceous and Tertiary age are known and have been mapped by the late Mr. Brynmor Jones, but the rocks of the Zamfara Valley belong chiefly to the ancient crystalline complex. These consist of schists, gneisses of various types, granites and minor intrusions. There appear to be three types of gold occurrence: (*a*) normal quartz veins associated with the schists, (*b*) thin but often rich stringers within both gneisses and schists, (*c*) in dykes.

The auriferous veins within the schists consist of milky quartz, and sulphides may be associated with the mineralisation. They tend to be grouped in zones, usually not far removed from igneous rocks, and seem to be steeply-lying lenses of different extent and thickness. The quartz-limonite veins are as a rule narrow and often occur in the gneisses and may be accompanied by local shearing. They may pass from gneiss to schist and are often associated with large barren quartz reefs. The dykes consist almost entirely of quartz-felspar threaded by quartz stringers. It is not at all clear whether the gold occurs in the quartz-felspar rock or in the stringers. Although the investigation is still in its initial stage it is clear that while the schist belts are important areas of gold production those consisting of gneisses and minor intrusives are important also.

Salt.—Towards the end of the year a local shortage of salt directed attention to the numerous brine springs in the Eastern part of the Protectorate and a brief examination of a number of these was made with the idea of increasing production for local use.

Water Supply.—The borehole at the Gidan Yari was completed and fitted with a pump and stand-pipe. It was tested to deliver 19,000 galls. per hour and now supplies water to the town, prison, military prison, and trading quarters to the amount of half a million galls. per month. Another borehole for the general supply for the city has been finished at a depth of 453 ft. and the necessary pilot holes were being drilled. The development of the gravel screen has been almost completed and on the return of the Drilling Superintendent from leave it is hoped to begin test pumping.

Well sinking in most areas, owing to the lack of materials and supervision, has been put on a maintenance and repair basis. In some of the northern areas military requirements have necessitated a certain amount of new sinking. In the south the programme in Owerri was completed and that in Aba is drawing to a close. Work was started in the Abak Division of Calabar Province and later in the year in Uyo Division. The results were distinctly satisfactory and there is room for considerable expansion of well sinking in these districts. During the year 76 wells were completed.

The Geology and Mineral Deposits of the Erongo Area, South West Africa.—The Erongo Mountains of South West Africa have long been a centre of geological interest, and the surrounding tin fields which contain a wide variety of pegmatite minerals—tantalite, wolfram, rutile, lithia minerals, gem stones, etc.—have been known for 30 years. The geology of the area was first investigated in 1910 by the German geologist, Dr. Hans Cloos. In 1927 and 1928 the region was mapped by the Geological Survey of the Union and a re-examination with special attention to the mineral deposits was made in 1936 and 1937. The results of this work have now been published as two geological maps on the scale 1 : 125,000 and accompanying explanatory reports of the Omaruru Area (Sheet No. 71), 1939, and the Karibib Area (Sheet No. 79), 1942. These two reports cover the area between 15° and 16° east longitude and 21° and 22° south latitude, with the Erongo Mountains in the centre.

The plains surrounding the Erongo are built of rocks of the Fundamental Complex, mainly quartzites, crystalline limestones and schists of the Damara system intruded by the Old granites. A Marble Series within the Damara system forms long ranges of hills which are a characteristic feature in the landscape. The Old granites were intruded at the close of the folding movements to which the Damara sediments were subjected, the most widespread types being the Salem granite, a grey porphyritic biotite-granite having a relatively high ferric content, and a later non-porphyritic granite with a lesser content of ferric minerals. The closing stages of this igneous activity gave rise to the aplites, pegmatites and pegmatitic quartz bodies with which are associated most of the mineral deposits in the area.

The Erongo Mountains rise with precipitous slopes from the plains, and have an oval outline, roughly 25 miles across, with the highest summits over 7,000 ft. above sea-level along the outer edge and surrounding an elevated plateau. They consist of a succession of sedimentary rocks and lava flows resting unconformably on the folded rocks of the Fundamental Complex, and intruded by granodiorites and granites. Cloos referred these rocks to the Waterberg system, but they are now considered to be much younger and are classed as doubtfully of Karroo age. The earliest igneous rocks were basaltic lavas which extended far over the region and were followed by successively more acid lavas and stocks of diorite and granodiorite forming the interior of the mountains, and finally by peripheral intrusions of the Erongo granite. No mineralisation is associated with the Erongo granite within the main mountain group, but on two outlying mountains, the Kranzberg and Klein Spitzkoppe, tin and tungsten mineralisation is found, which is clearly related to the Erongo granite magma.

The tin deposits of the Erongo area occur in three main belts, a northern belt running westwards from Uis, which lies to the west of the Omaruru map area, a central belt lying to the north of the Erongo mountains in the Omaruru map area, and a southern belt to the south of the mountains in the Karibib map area. In recent years the whole field has yielded from 200 to 240 long tons of 70 per cent. tin concentrates annually. The deposits of the southern belt may be divided into 19 groups extending over a distance of 60 miles from west to east. Both pegmatite and detrital deposits have been worked, the most extensive being eluvial deposits at

Amieb which have been exploited since 1910. In 1935 the Amieb workings yielded about 4½ tons of concentrates a month, but production has since declined and work ceased early in 1939. In the central belt about seven groups of deposits are recognised, the most extensive occupying a strip of country over 20 miles long and about 2 miles broad on the N.W. bank of the Omaruru river between Neineis and Tsomstaub. Here the principal producer is the Humdigams mine which produces 4 to 5 tons of concentrates monthly from rich pegmatite veins which may average over 4 per cent. of cassiterite. Alluvial deposits are worked at Neineis, Paukuab and Kohero in ground usually carrying less than 0·5 per cent. of cassiterite, but the output is small, about 1 ton per month from each locality. Where water is not available the cassiterite is extracted from eluvial and alluvial material by crushing and winnowing. Interesting deposits occur on the Kranzberg which are much younger than the main tin deposits. Here cassiterite occurs in steeply dipping joints in the Erongo sediments, accompanied by tourmaline, beryl, quartz and fluorite, and also in the breccia filling of two volcanic pipes, as well as in quartz-tourmaline veins in the non-porphyritic granite.

The pegmatites in which the tin is found are best developed in the Damara schists near contacts with the Old granites, especially where the schists are steeply dipping, the pegmatites usually following the strike of the schists. Three groups are recognised, characterised by tourmaline (schorl), garnet (spessartite-almandine) or cassiterite. Many other secondary minerals accompany the cassiterite, but the most widespread and important from a genetic point of view are schorl, coloured lithia-tourmalines, muscovite, lepidolite, triplite, and to a lesser extent sulphides such as those of molybdenum, bismuth, arsenic, copper and iron.

Most of the deposits are small and sporadically mineralised and show rather variable characters, but the following generalisations may prove helpful in prospecting the deposits. Certain structural features are frequently accompanied by rich mineralisation, as, for instance, where a pegmatite suddenly thins or takes a vertical or lateral twist or pinches out upwards, or where two pegmatites intersect. In the latter case the later dyke usually carries the ore. In folded or undulating pegmatite dykes the cassiterite frequently occurs in the saddles, and in synclinal dykes on the footwall. Inclined dykes carry cassiterite mainly on the hanging wall, but it may also occur on the footwall and occasionally throughout the dyke. Narrow schist belts bordered by granites often carry numerous pegmatites, especially where the belt changes strike, and the pegmatites in the centre of the belt are usually the richer in tin. Fresh felspar-rich pegmatites forming prominent features are generally poorly mineralised, while dykes with abundant mica or greisenised selvages, usually less resistant to weathering, are more likely to carry tin. Pegmatites with schorl or garnet seldom contain cassiterite, but abundant secondary muscovite and albite is usually associated with cassiterite. Fine-grained cassiterite often accompanies nontronite; and malachite, azurite or limonite staining may also indicate stanniferous pegmatites. Although individual deposits may pinch out at shallow depths this is interpreted as being due to discontinuous mineralisation rather than to restricted zones of deposition, for series of reefs bearing cassiterite can be traced with vertical ranges up to 1,300 ft.

Tantalite-columbite minerals are generally associated with cassiterite in the stanniferous pegmatites, usually in highly albitised portions, and although they occur in small amounts and are erratically distributed, a few of the tin mines have concentrated them from time to time. The percentages of tantalum and columbium in these minerals vary a great deal in the various deposits, but usually columbium preponderates. The following are the percentages of Ta_2O_5 found in samples from different localities: Thelma mine 31, Sandamap 30 to 47, Arakas 27·35, Erongo Schlucht 9·4, 9·8 and 42·2, and Cillier's working and Davib mine 60 to 65. Only 2 or 3 tons of tantalite-columbite have been produced annually in recent years.

The principal deposits of tungsten ores in South West Africa occur in the Omaruru map area, the most important being situated on the Kranzberg. Here wolframite is found in quartz-tourmaline veins, as replacement deposits in quartzites at contacts with schists or the Salem granite, in quartz-topaz rocks, and in stringers and drusy cavities in the Erongo sediments, but in all cases the mineralisation is clearly related to the Erongo granite. The quartz-wolframite lodes follow the bedding planes of the schists and are up to 16 in. in thickness, but the wolfram is impersistent and usually found only in the central portion of the lode over a width of 3 or 4 in. Several other occurrences of both wolframite and scheelite have been found, and although most of them have been prospected little ore has been produced from them. A characteristic feature of the tungsten ores is that they are almost invariably accompanied by very fine-grained and frequently massive granular tourmaline, and the richer deposits usually occur in quartz veins in the schists.

An interesting deposit which is worked for rutile occurs on the Giftkuppe, an inselberg composed of massive white quartz-albite rock, probably an albitised granite, situated 18 miles north of Karibib. The rutile occurs in highly altered portions of the quartz-albite rock disseminated along drusy fissures in bands up to 8 ft. in width. The crystals are very large, including beautiful specimens up to 6 in. in length, and are associated with quartz and green chromiferous mica. After blasting, the rutile is hand picked from the loose material and any adhering gangue removed by crushing, screening and simple gravity methods. Analysis of rutile shipments has shown 95·87 per cent. TiO_2, 2·5 per cent. SiO_2 and 1·8 per cent. Fe_2O_3, while in another parcel only 0·7 per cent. Fe_2O_3 was present.

About 80 tons of rutile have been extracted from this deposit and the workings are by no means exhausted.

Lithium-bearing minerals such as lepidolite, amblygonite and zinnwaldite occur in pegmatites associated with prominent quartz blows, but within this area the deposits appear to be too small to be of economic interest. Zinnwaldite mica from the Erongo Schlucht contains 3·2 per cent. Li_2O and amblygonite occurring south of the Davib mine contains 3·28 per cent. Li_2O, but only small quantities are available.

Appreciable quantities of beryl and topaz of gem quality have been found in drusy pegmatities of the Erongo granite at the Klein Spitzkoppe. The transparent beryl crystals include the aquamarine and heliodor varieties, and crystal-clear topaz occurs which makes very fine brilliants. In the early days of the field large quantities of aquamarine and topaz crystals were gathered from drusy pegmatites at the surface, but since these have been worked out quarrying and blasting have been resorted to and have proved unprofitable, particularly as the crystals tend to be damaged in the process. Common beryl is of widespread occurrence but does not appear to exist in sufficient quantities to warrant extraction as an ore of beryllium. Transparent crystals of tourmaline of red, blue and green colour have been found in small quantities in tin-bearing pegmatites at several localities, and crystals of gem quality have been obtained at the Carsie mine, the Davib mine, and at Cameroon.

Extensive deposits of marble of Damara age occur in the hills of the Dernburg range north-west of Karibib. The deposits are of comparatively high grade, and many varieties, white, grey, banded, dark grey, blackish, cream, and reddish in colour are present. They were worked before 1914 and some shipments were made to Germany, but the transport costs proved prohibitive.

The area has been extensively prospected for its mineral wealth but the majority of the deposits are small and sporadically mineralised, as is to be expected in pegmatite deposits. Few of the deposits warrant large-scale mining, and on the whole the present small-scale operation by separate owners on individual areas seems to be the only successful method of working such patchy, discontinuous deposits.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

Steels for the User. By R. T. Rolfe, F.I.C. Second Edition, revised and enlarged. Pp. xi + 356, 8½ × 5½. (London: Chapman & Hall, Ltd., 1942.) Price 25s.

The first edition of this book appeared in 1937 and was reviewed in this Bulletin, 1937, **35**, 413. The new edition has been revised and enlarged by the addition of 76 pages and 28 figures, and it is gratifying to note that the increase in price has been less than proportionate. A new chapter on weld testing and treatment has been included, and considerable additions have been made in the chapters on fatigue testing, heat treatment, and the principles of selection.

Alloy steels are not considered in this work, a feature which is perhaps to be commended at the present when plain carbon steels which can be made from domestic materials should be used wherever permissible so as to conserve imported ferro-alloys for essential purposes.

SECOND REPORT ON REFRACTORY MATERIALS. The Iron and Steel Institute, Special Report No. 28. Pp. iv + 168, 8½ × 5¼. (London: The Iron and Steel Institute, 1942.) Price 16*s*.

The present war has undoubtedly stimulated to a marked degree the important researches normally carried out in this country by the Refractories Research Committee of the Iron and Steel Industrial Research Council and by the British Refractories Research Association. For some time past these two bodies have been working in the closest and fullest co-operation, as was indeed patent in March 1939 when they issued conjointly their extremely valuable *First Report on Refractory Materials*, duly noted in this BULLETIN (1939, 37, 479). Since then the numerous experts concerned have gained a vast amount of additional data and works experience, especially in connection with alternative types of basic refractories such as stabilised dolomite—information which is of the utmost value to this country in wartime, owing to the difficulty of obtaining supplies of imported magnesite. Much of the new information is of necessity secret, though it is available to responsible officials of the iron and steel industry in the confidential bulletins of the British Refractories Research Association. As, however, certain of these bulletins contain scientific and technical papers of general and fundamental importance, it has been thought advisable to bring these papers together to form the basis of the present Report.

These papers are grouped into two main sections (B and C) dealing respectively with steelworks and blast-furnace refractories: they are sandwiched between two subsidiary sections (A and D) comprising a brief Foreword by T. Swinden and A. T. Green, and a concluding chapter summarising the numerous other published works of the British Refractories Research Association of interest to the iron and steel industry.

Section B on steelworks refractories begins with a statement of the work performed by the Open-Hearth Refractories Joint Panel during 1939-42. It is emphasised that (1) investigations on silica bricks have developed from a general survey to an intensive study of one particular furnace roof; (2) work on basic refractories has ranged from fundamental studies on the constitution of stabilised dolomite and chrome ores, to the preparation of test-sheets for the service testing of basic refractories in the open-hearth furnace;

(3) casting-pit refractories have several times been discussed in general terms, with the result that a sub-committee has been formed to deal with this side of the Panel's work.

A detailed and comprehensive paper now follows on the study of the reactions between dolomite and various minerals, the paper being divided into four parts, the first of which, by J. R. Rait and A. T. Green, being devoted to the probable constitution of fired clinkers. Moulded mixtures in various proportions of dolomite with flint, steatite, bentonite, china-clay, olivine, serpentine, open-hearth slag, alumina, ferric oxide, zircon, baddeleyite, zirconia, rutile, chromite, and chromium oxide were fired at about 1,500° C., and subjected to tests for the presence of free lime and for their hydration indices. A mathematical method was then devised, based on a consideration of the relevant phase rule diagrams and of the chemical analyses of the clinkers, assuming that the magnesia was present uncombined as periclase in all cases, for the probable mineralogical constitutions of the fired mixtures. The validity of this method was subsequently established by J. R. Rait and H. J. Goldschmidt, who have contributed the other three papers which deal with the X-ray examinations of the Dolomite B—Steatite A Series, and of the sinters containing zirconia. Their work is based essentially on X-ray powder analyses of the mixtures using a Debye-Scherrer camera and a microphotometer (Photronic or photoelectric cell) in conjunction with a galvanometer for the quantitative measurements of the intensities of the lines produced by the crystalline powders.

As a result of these experiments, the relative effectiveness of different materials as stabilisers for Dolomite B (CaO 29·27, SiO_2 3·86, Al_2O_3 0·99, Fe_2O_3 0·98) was found to be as follows, the required accuracy in the preparation of the raw mixes decreasing notably from the first to the last-named stabiliser.

Stabiliser.	Minimum Per cent. (weight) Stabiliser required for Complete Combination with Lime.	Hydration Index (*Per cent.*)
Flint	5·6	3·2
China-clay	7·8	4·2
Open-hearth slag	7·8	3·9
Bentonite	8·5	3·5
Alumina	9·0	11·0
Steatite A	9·6	3·5
Steatite 3B	10·2	4·7
Rutile	10·5	5·0
Zircon	11·0	3·0
Synthetic zircon	11·7	3·4
Olivine	12·0	3·4
Steatite F.G.X.O	12·5	3·1
Steatite A.T.I.	13·2	3·1
Serpentine	14·0	1·5
Chromite B	17·3	1·5
Chromite A	18·0	1·0
Synthetic chromite	18·0	1·4
Chromic oxide	18·0	0·4
Ferric oxide	19·0	3·0
Baddeleyite	21·8	3·8
Zirconia	26·4	2·7

Section B concludes with a note by W. J. Rees on a simple partially stabilised dolomite mixture, the stabilisation being brought about by the addition of comparatively small amounts of ball clay and mill scale to the ground dolomite.

Section C on blast-furnace refractories consists of two important papers, the first being a discussion by G. R. Rigby and A. T. Green on the influence of working conditions on the durability of furnace linings, and the other, by G. R. Rigby, H. Booth and A. T. Green, on the temperature gradients through such linings. Valuable influences have been drawn relating to the segregation of the burden in the stack and the driving of the furnace generally. It is considered possible from the temperature records to compute with reasonable accuracy the thickness of the lining in front of any thermocouple, and thereby to obtain an estimate of the lines of the furnace at any particular time during the campaign.

As in the First Report, extensive use has been made in the present work of tables showing experimental results, and of explanatory photographs and diagrams. It is more than gratifying to see that even under war conditions such excellent work as this is being produced.

DIAMOND AND GEM STONE INDUSTRIAL PRODUCTION. By Paul Grodzinski. Pp. 256, 8½ × 5½. (London: N.A.G. Press, Ltd., 1942.) Price 15*s*.

That there has hitherto been no modern and comprehensive book in the English language on the technology of the production of diamonds and other precious and semi-precious stones both for gem and industrial purposes, is largely due to the fact that in spite of this trade having been once carried on principally in England, for a very long time the industry has been centred on the Continent.

An attempt to remedy this state of affairs at a time when diamond cutting has again been established on a considerable scale in this country was made when in December 1940 a supplement to the *Goldsmiths' Journal* called the *Industrial Diamond Review* containing useful and informative articles on the industry first made its appearance. This has now been followed up by the publication of a text-book produced by the efforts of the publishers of that review and their technical consultant, Mr. Paul Grodzinski.

The book is divided into two parts. The first deals with the general technological methods and machinery employed in cleaving, sawing, bruting, cutting and polishing diamonds and of boring holes in and carving and engraving precious stones; there are also sections on diamond powder and bonded diamond wheels. The second part deals with more specialised methods used in the manufacture of diamonds, gemstones, instrument bearings, diamond and hard-metal dies, with the setting of industrial diamonds and with the grinding and lapping of sintered carbides. Appendices deal with the nature and uses of other hard materials in industrial use.

The book is copiously illustrated with line drawings of machinery and tools used in the industry. While it represents a praiseworthy effort to fill a very notable gap in English technological literature, the treatment of the subject matter is by no means profound or erudite, and the book, therefore, will appeal more to those interested in gaining a superficial insight into the technique employed in the preparation of rare stones for both gem and industrial purposes rather than to specialists in the industry.

It is regrettable that the manuscript of this book was not read and corrected more closely by the publisher, for its usefulness is considerably impaired by the strange language employed which often renders the meaning dubious and obscure.

MINES REGISTER. Successor to the Mines Handbook and the Copper Handbook. Vol. XXI, 1942. Pp. 742, 9 × 6. (New York: Atlas Publishing Company, 1942.) Price $15.00.

This well-known work of reference dealing principally with the non-ferrous metal mining companies of the Western Hemisphere and, within recent years, also with a selected number of the larger mining companies in other parts of the world, has now reached Volume 21 in the series which commenced in a different guise in 1900. The previous issue (Vol. XX) appeared in 1940 and was noticed in this BULLETIN, (1940, 38, 505).

Although the United States was, of course, not actively in the war in 1940, the repercussions of hostilities in other parts of the world had even then had a considerable effect on the mining industry of the States and the intensification of this position in 1941 led to still further changes in both mines and personnel, and to the necessity for another edition of the Register. These changes consist chiefly in the stepping up of production by existing mines, the resuscitation of properties long dormant and the coming into production of entirely new properties. Nevertheless it would appear from the fact that only 4,000 active mines are listed in this latest edition against 7,000 in 1940 that a number of small-scale uneconomic producers have been eliminated in favour of expansion at existing mines and development at new ones.

As in former editions of this work its scope consists essentially in an abbreviated description of the principal non-ferrous metal-mining companies of the Western Hemisphere. Where available, this information consists of the official title of the company, the address of its registered office, its chief officers, history, capitalisation, earnings, dividends, assets, location, nature of mine and mill, ore reserves, output and number of employees, but such details are given only for the active mines. Following former procedure, this is supplemented by a list of the inactive or dormant mines, more details concerning which can often be found in previous editions of the Register.

A very welcome innovation in this latest edition is the inclusion of a geographical directory of the mines listed. Those familiar with the old *Mines Handbook*, the ancestor of the *Register*, will remember that the procedure there was just the reverse, that is, the mines were classified geographically with an alphabetical index of names of companies, a very useful arrangement for very many purposes.

At present this geographical list is confined to the Americas, with which the book is primarily concerned, but the extension of this classification to include the selected small number of foreign mines listed might usefully be undertaken in future editions.

Other established features of the Register which are retained include the alphabetical list of mining officials with the companies to which they are affiliated, the statistical section of non-ferrous metal production, movements and prices, the high and low share quotations of the principal securities between 1933 and 1941, the addenda of information received too late for classification and the "Where to buy" supplement printed on coloured paper for quick reference.

We ourselves have been rather sorry to see with each succeeding volume in this series, the progressive decrease in the amount of information it provides concerning the geology, nature and tenor of the ore-bodies, and details of the plant employed and type of final product or concentrate produced, but our viewpoint is perhaps somewhat specialised and to a wide variety of users *The Mines Register* will continue to prove an invaluable work of reference.

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The publications issued by the Governments of the Colonies and Protectorates can be obtained from or through the Crown Agents for the Colonies, 4 Millbank, Westminster, S.W.1. Applications for Dominion and Indian Government publications may be made to the Offices of the High Commissioners or Agents-General in London.

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COMMERCIAL INTELLIGENCE

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EXHIBITION GALLERIES, FILM LIBRARY AND CINEMA

NOTES

Exhibition Galleries.—Although still closed to the general public, the Galleries are visited by increasing numbers of organised parties who come by arrangement to see specific courts or groups of courts representing countries or subjects in which they are particularly interested. These parties are usually met and conducted by the Director or the official Guide Lecturer, and occasionally by members of the Collection's Staff. The lecture demonstrations given in the Galleries are in most cases followed by a display of associated films in the Cinema, the films serving to recapitulate the lecturer's remarks and to complete the mental picture.

In recent issues of this BULLETIN detailed lists of these organised parties have been given but in view of the need for conserving space the following summarised statement has been prepared: Compared with the first quarter of 1941 the number of organised parties who visited the Galleries in the corresponding period of 1942 has more than doubled, the respective totals being 15 and 33; whilst during the second quarter the total has more than quadrupled being 11 in 1941, and 45 in 1942.

The parties fall into the following categories: (*a*) United Kingdom and Dominion Troops, of whom there were 5 parties in the first quarter of 1942 and 10 in the second quarter, as against nil in 1941; (*b*) Indian Troops and Labour Trainees represented by 13 parties in the first quarter of 1942 and 10 in the second as against nil in 1941; (*c*) Colonial and Foreign evacuees, of whom there were 3 parties in the first and 3 in the second quarter of 1942, as against 14 and 11 parties in the corresponding periods of 1941, the falling oft being probably due to the absorption into industry of a number of evacuees; (*d*) Learned and Empire Societies represented by only one party in the first quarter of 1941 and none in the second, as against 6 in the first and 6 in the second quarter of 1942; and (*e*) Schools and youth organisations, who in peace-time comprise the majority of our visitors, supplied 6 parties in the first quarter of 1942 and 16 in the second quarter as against nil in the corresponding period of 1941.

These figures are encouraging as showing a sustained and increasing interest in the Exhibition Galleries, and what they stand for, despite the enforced closing of the doors to the general public owing to circumstances of the war; they are also of good augury for the future when once again it will be possible to remove the existing regulations restricting visits only to organised parties.

New Exhibits.—The most important new acquisition is a miniature diorama of the Mawchi Mines which has been installed in the Burma Court. This diorama was constructed in the Imperial Institute Studio and is the work of Mr. Herbert H. Cawood; funds to meet the cost had been generously donated by the Directors of Mawchi Mines Ltd., who also supplied an interesting range of tungsten ores and concentrates from the mines and a plan of the workings to associate with the diorama.

The descriptive label for the diorama reads as follows:

The Mawchi Mines

" The Mawchi Mines are situated in Karenni State at the southern end of the Southern Shan States and about 65 miles east of Toungoo.

" The lodes lie in the upper portion of the long ridge seen in the background of the diorama. The strike of the ridge is east and west, and that of the lodes is approximately at right angles to it.

" The ore as mined is sent down by means of an aerial ropeway to the treatment plant shown in the foreground. The latter is about 2,200 ft., and the highest point in the ridge about 5,000 ft. above sea-level.

" The miners' quarters are situated on the ridge. The general manager's bungalow, and most of the staff bungalows, are on the conical hill, the road up which can be seen to the left; the hospital and some other European quarters stand about one-third of the way up the conical hill. In the mill camp seen in the middle distance are situated bungalows for Europeans and workers employed on the treatment plant, the assay office, the power plant, etc.

" The stream which flows below the treatment plant to Kemapyn on the Salween river is called the Kemapyn Chaung. The 'Mine Chaung' empties its waters into the Kemapyn Chaung to the left of the treatment plant just below the dam in which water is conserved for the hydro-electric plant."

To the Cyprus Court has been added a story exhibit illustrating the Colony's principal mineral, cupriferous pyrite. Under the title " Cyprus Pyrites—a Source of Sulphuric Acid " it traces the production of this mineral, and the many stages through which it passes in yielding sulphuric acid, the world's principal industrial chemical, and also the manner in which its copper and iron constituents are liberated.

Central Film Library.—The number of films in the Library and the circulation of the films continue to increase. In the six months February to July 1942, 46,300 films were despatched. Negatives of a number of films not at present in the Library were received in July from Australia and New Zealand and part of a further grant received through the generosity of the Imperial Relations Trustees will be spent in printing copies of these films for circulation. Further new films about Canada and India are also being added to the Library. At the same time further copies are being printed of films about the Empire already in the Library. About six new Ministry of Information films are being added to the Library every month.

Empire Lantern Slide Library.—The circulation of lantern slides of the Empire to schools, women's institutes, societies and army educational authorities during the period February to July 1942, totalled 22,400. The details are shown in the following table:

	February.	March.	April.	May.	June.	July.
United Kingdom . .	200	100	100	50	100	100
Australia	550	350	550	200	400	200
Canada	800	650	500	300	200	50
New Zealand . . .	300	200	—	150	250	50
South Africa . . .	100	200	200	—	150	100
India	550	550	350	450	250	200
Burma	400	450	200	350	200	—
Territories of the Colonial Empire	2,000	2,300	1,050	850	1,450	1,200
Products of the Colonial Empire	100	50	200	200	200	—
General Tours . . .	650	200	50	150	200	50
History of the Empire .	150	50	100	150	—	—
	5,800	5,100	3,300	2,850	3,400	1,950

Five new Picture Talks have been printed during this period of six months. Two of them were written by Mr. Toye Vise and presented to the Institute by the Empire Tea Bureau.

"The Tea Gardens of India" gives a very brief and general survey of India and then tells the story of the establishment of the tea industry and its development during the past century. The lay-out of the tea plantations, the conditions of labour and the care which is taken of the health and welfare of the workers are illustrated, and finally we see the processes by which the green leaf is turned into the tea we know.

"Tea Throughout the Empire" opens with the history of tea as an article of trade and commerce, its introduction to this country, its great popularity and the increase in consumption as prices decreased. Production in Ceylon, East Africa, Natal and India is described, and the preparation of tea for export.

"India's Winter or 'Kharif' Crops," by Mr. R. D. Anstead, C.I.E., M.A., illustrates the cultivation of wheat, groundnuts and sunn hemp.

"The Nilgiris and Malabar Coast" is a Picture Talk written round a set of Dufay Color photographs presented to the Institute by Mr. S. Jepson. The story is mainly of the peoples, temples and palaces of Southern India.

"The British West African Colonies," written by Mr. L. H. Saunders, who also presented many of the photographs, is a general talk on the peoples and customs of West Africa. Illustrations of Freetown, Accra and Kano City are followed by pictures of African soldiers, police, women, girls and children. We see how the women plait palm leaves, carry the rice harvest and pound the grain, while the men and boys build huts, climb palm trees and scare birds from the corn fields. Bee-keeping, metal working, weaving and dyeing cloth, the making of ropes, fishing nets, and dug-out canoes are described and the talk ends with pictures of flowers and flowering shrubs of West Africa.

Imperial Institute Stories of Empire Products.—The second series of six posters and descriptive leaflets dealing with some typical colonial foodstuffs and raw materials to which reference was made in this BULLETIN, 1942, 40, 96, has been completed with the publication of Nos. X, XI and XII.

As in the case of the earlier issues the leaflets contain small-size reproductions of the posters and give notes, primarily intended for the use of teachers, explaining the various vignettes in the picture stories.

No. X treats of " British Guiana Rice—the sugar-growers' daily bread," and gives a short account of the introduction of rice to British Guiana by the Dutch early in the eighteenth century and the development of the industry following the influx of East Indians for working the sugar estates. The methods of cultivation, harvesting, threshing, par-boiling and milling are then briefly described. The finished product, mainly consumed by the local Indian population in British Guiana, is distributed in the world's market as " Demarara Rice."

The subject of No. XI is " Kenya Coffee—the bean that cheers." This story starts with a description of a drawing of flowering and fruiting sprays of the coffee plant, and a dissection of a coffee cherry showing the beans in their wrappings of silver-skin and parchment. Then follow descriptions of the processes of picking, pulping, fermenting, washing and drying, hulling or peeling, and the grading and hand-picking of the beans; finally the roasting and grinding of the beans for the preparation of " morning coffee."

No. XII describes the contribution of Nigeria to the world's supply of hides and skins, the produce of livestock, mainly domestic cattle, goats and sheep, owned by nomadic pastoral tribes and peasant farmers. The local treatment of the hides and skins previous to baling and export is described; also the operations preliminary to tanning, and the tanning processes to produce finished leather that reaches the consumer in the form of boots and shoes, bags, gloves, clothing, saddlery and harness and a host of other articles of everyday use.

Empire Lectures to Schools.—The end of the summer holidays is an appropriate time at which to review the progress of the Imperial Institute Scheme for Empire Lectures to Schools.

Since the scheme was resumed in September 1941, many more schools all over the country have taken advantage of this service, and lecturers have been very busy meeting the many requests which have been received. The number of lectures given during the period September 1941 to August 1942 reached 768, an average of 64 per month. Of the subjects selected by the Heads of schools, 299 related to the Dominions, 135 to India, 232 to the Colonies and 102 to general Empire subjects. The aggregate audiences totalled 126,098, made up as follows:

Northern counties	40,627
Western counties	10,060
Midland counties . . .	39,085
Southern counties	36,326

It is confidently expected that these figures will be appreciably increased now that many of the schools are regarding the Imperial Institute lectures as an integral part of their study of the British Empire.

It is gratifying to be able to record this progress; but even more interesting than statistical results are the following points which have been noticed in connection with the scheme. In the first place, although May, June, July and August are months which are affected by holidays and examinations, the number of requests for lectures continued to increase during these particular months of 1942. Again, many schools, after their first lecture, tend to ask that the same lecturer should be sent to them again to develop fresh aspects of a particular subject. Further, the lecturers, with whom we keep in close touch, report that the questions which the children put after the lectures indicate the keenness with which the children have followed their talks. These and other reports give us confidence that the scheme holds the vital elements of steady and continuous growth.

In order that remote or out-of-the-way schools should receive the benefit of visits from lecturers, tours in certain regions have been arranged: the *modus operandi* is as follows: A region from which only a few applications for lectures had been received is selected; lecturers are approached and invited to hold themselves in readiness for a tour of say a week or ten days; masters and mistresses are then notified that lecturers are prepared to visit their schools and to talk on various parts of the Empire during a given period. Had such tours not been arranged, it is conceivable that many of the schools would not have been in a position to participate in the lecture scheme. As it is, these tour lectures have proved most successful and have been much appreciated by teachers and schools alike. It is a practical instance of our definite policy to "bring the mountain to Mahomet."

For the schools nearer London, i.e. in the Home Counties, arrangements are made whereby lecturers attend certain schools for, say, three succeeding weeks to talk about selected parts of the Empire. On the fourth week, at the conclusion of the lectures, the school party visits the Exhibition Galleries of the Institute, where products and photographs are explained and a display of films is given in the Cinema. By this means it is not difficult to instil into the minds of the scholars a comprehensive knowledge of the British Empire; and to those who consider the part which our Empire will play in the post-war world, the promotion of this knowledge in the younger people becomes quite clearly a matter of great significance. Thus these lectures to schools throughout the country should not only constitute an important Empire Service but should also directly influence the younger generation in the thoughts which shape international affairs.

Colonial Visitors.—The following is a list of officers on leave from the Colonial Empire who have visited the Institute during the period February-July 1942.

FEBRUARY

H. E. CHUDLEIGH, Labour Adviser, Palestine.
H. C. KING, Assistant Conservator of Forests, Mauritius.
J. B. G. SAVORY, Agricultural Officer, Nigeria.

MARCH

M. T. HORWOOD, Assistant Conservator of Forests, Gold Coast.
Captain P. F. MASTERTON-SMITH, M.C., District Officer, Nigeria.

APRIL

W. M. BISSELL, Labour Adviser, British Guiana.
E. H. M. COUNSELL, District Officer, Nigeria.
J. D. GILLESPIE, Agricultural Superintendent, Sierra Leone.
The Hon. J. H. B. NIHILL, K.C., Puisne Justice, Supreme Court, Ceylon.
G. D. PROCTOR, Senior Inspector of Factories, Trinidad.
C. V. WILLIAMS, District Officer, Nigeria.

MAY

EDGAR PARRY, Labour Adviser, Sierra Leone.
J. W. A. THORBURN, Senior Education Officer, Nigeria.

JUNE

D. W. H. BAKER, Agricultural Officer, Nigeria.
Dr. F. C. BENHAM, Economic Adviser to Comptroller for Development and Welfare, West Indies.
Professor G. H. LUCE, University College, Rangoon, Burma Educational Service.
J. C. K. MARSHALL, Senior Assistant Conservator of Forests, Federated Malay States.
Miss A. M. MCMATH, Lady Education Officer, Sierra Leone.
R. F. A. L. REED, Agricultural Officer, Nigeria.
Captain N. A. C. WEIR, District Commissioner, Sierra Leone.

JULY

A. J. LOVERIDGE, District Commissioner, Gold Coast.
Captain L. NICHOLLS, M.C., Deputy Chief Conservator of Forests, Nigeria.

All Dominion and Colonial Officers, as well as private residents overseas, who may be visiting London, are cordially invited to come to the Institute to see the Exhibition Galleries and to discuss scientific and technical problems in which they may be interested.

BULLETIN
OF THE IMPERIAL INSTITUTE

VOL. XL. NO. 4. OCTOBER-DECEMBER, 1942

PLANT AND ANIMAL PRODUCTS

NIGERIAN CASSAVA STARCH

By J. R. FURLONG, Ph.D., A.I.C.,
Vice-Principal, Plant and Animal Products Department, Imperial Institute

PRIOR to this war the world's trade in cassava starch, or tapioca flour as it is usually called in commerce, had reached large proportions. In 1939 the total value of the product entering commerce was in the neighbourhood of £900,000, of which about 95 per cent. came from the Netherlands East Indies. The restriction of shipping facilities as a consequence of enemy action led to short supplies of Java cassava products, and the events in the Far East which closed this area of production to the Allied Nations made the position still more acute. The material is of war importance, being required for the manufacture of dextrine and adhesives and for other industrial uses, and the development of sources of supply near home became imperative.

In Nigeria *Manihot utilissima*, whose roots yield cassava starch, is widely grown as a local foodstuff, the roots being grated and dried to form the product known as " garri." A crude starch has also been prepared in some parts for local consumption. For some years past the possibility of producing cassava starch of good quality for export has been studied by the Nigerian Department of Agriculture, and since the close of 1940 the Imperial Institute has collaborated in this work, giving advice on methods of evaluating the starch and examining and reporting on samples prepared by the Department. An account of the part played by the Institute in this investigation is given in the following pages. This consists of reports on two batches of starches submitted for examination and a discussion on the basis for judging the commercial quality of cassava starch. Mr. K. T. Hartley, Senior Agricultural Chemist, Nigeria, who was responsible for the work in Nigeria, has very kindly written a statement on the method of preparing the starch worked out and adopted there, and this is printed as an Appendix to this article.

The outcome of this work is that Nigeria can now supply the United Kingdom factories with high quality starch. It has so far not been possible to provide the equipment necessary to produce the finely divided product which the market previously knew, but for the present fine-grinding can be accomplished in the United Kingdom for purposes for which finely divided starch is essential.

Before this war the Netherlands East Indies shipped as much as 15,000 tons of cassava starch to the United Kingdom in a single year. It is thus seen that the present affords a good opportunity of introducing to this market the Empire-produced starch and of developing the production of the latter on careful lines so that the market secured during war conditions may be retained when competition is renewed in the post-war period.

It is not anticipated that Nigeria will be able to supply all the home needs for many years to come, but the success of the initial experiments in that country will it is hoped encourage other Empire countries where cassava is grown to take up the manufacture of the starch.

I. Evaluation of Cassava Starch prepared in Nigeria

In this section is given a description of the samples of cassava starch prepared in Nigeria and the results of their examination at the Imperial Institute.

REPORT ON FIRST BATCH OF SAMPLES

These samples, six in number, represented different varieties of cassava grown by the Agricultural Department. The starch was prepared under departmental supervision by one African woman, and they were intended to be the beginning of an investigation to determine whether different varieties of cassava yielded varying types or qualities of starch. It was doubted whether the process of preparation was sufficiently standardised at this stage to yield strictly comparable results.

Description

The samples, weighing from 5 to 10 oz. each, consisted of starch in powder form, and were as follows:

No. 13 (*C* 997 *B*). Very good colour.
No. 14 (*CH* 28). Very good colour.

No. 15 (*Ogunjobi I*). Poor colour.
No. 16 (*Ogunjobi II*). Very good colour.
No. 17 (*CH* 50). Good colour.
No. 18 (*CH* 128). Very good colour.

In all samples the material consisted of fine and granular powder and lumps, being in this respect very faulty, since good quality starch should be an even fine powder. Nos. 14 and 16 were the most friable, while the lumps in No. 15 were the hardest and most difficult to reduce to powder.

*Chemical Examination**

Sample No.	Moisture.	Protein.	Crude Fibre.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
13	12·2	0·22	0·05	0·20
14	12·2	0·11	0·05	0 06
15	12 2	0·33	0·15	0·24
16	12·2	0·15	0·05	0·16
17	12·4	0·18	0·10	0·18
18	12·3	0·15	0·13	0·20

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* The analytical work on the samples examined at the Imperial Institute was carried out by Mr. F. Major and Mr. H. E. Coomber.

The analytical figures show No. 14 to be the cleanest and best washed sample, followed by No. 16. Nos. 13, 17 and 18 are alike in this respect, while No. 15 is inferior to the others.

Commercial Valuation

(1) The starches were submitted to a firm of brokers who, judging the quality by appearance, placed the samples in the following order of market value: Nos. 13, 14, 16 and 18 are the best, and are of equal value, followed by No. 17, while No. 15 is the least satisfactory.

The firm stated that all the samples would be saleable in the present condition, but owing to the lumpy nature the price would be below that of the same starch in the form of a fine powder free from lumpiness.

(2) The samples were submitted to a firm of dextrine and adhesive manufacturers for dextrinisation trials.

In these trials the starches were converted into dextrine under conditions comparable with commercial production. The firm reported as follows:

"The samples have all been dextrinated under identical conditions and the order of merit is as follows:

14, 16, 17, 18, 13 and 15.

"The first two, 14 and 16, make excellent dextrine and should be described as 'superfine,' 17 is of medium quality, 18 and 13 are inferior and 15 is bad. It is not clear whether the inferiority of 15 is due to the variety of the root from which it is made, or from the use of too much heat in drying the starch after washing, and it rather looks as if drying was the cause of the trouble. If the temperature exceeds 130° F. in the drying before all the moisture is extracted the starch becomes what, for want of a better term, may be described as 'vitrified.' In other words it is just as insoluble as bread and is useless from the dextrine maker's point of view.

"All the samples submitted were granular and are not suitable for dextrinising in that condition. The starch usually supplied to dextrine makers is in the form of a fine powder and the starch from which these samples are taken would either have to be ground and dressed before dispatch from the source or after delivery. It would be very much preferable that this process should be carried out at the source where labour is cheaper and the starch delivered ready for use."

The firm also stated that although samples Nos. 18 and 13 had been described as inferior, all the samples except No. 15 would, if properly ground to a fine condition, be saleable for dextrine making. No. 15 even when ground would be unsuitable.

Remarks

The object of the investigation was to ascertain whether the different local varieties of cassava root yielded starches of varying quality. For such determination the starches should be prepared under identical conditions. The Agricultural Chemist, in his letter of advice, doubted whether the method of preparation employed had been sufficiently uniform throughout.

The chemical analysis showed that with regard to purity of the starch the preparation had varied. The differences were not large, but sufficient to show that Sample No. 14 had been very well washed, while No. 15 was the least satisfactory in this respect. The varying colour and appearance of the samples also indicated that the thoroughness of the preparation had varied.

The dextrinisation tests showed very clearly differences in quality from the dextrine maker's point of view; in this connection another factor in the preparation of the starch is concerned, namely the method of drying after the washing has been completed. It is believed in the trade that too-rapid drying causes a condition known as "vitrification" which prevents the dextrinisation of the starch to a more or less degree. This condition is not disclosed by the general appearance or analysis, but by actual dextrinisation test.

It will therefore be seen that since there is evidence of variation in preparation of the starches examined the differences recorded above in the quality of the samples must not be interpreted as due to the variety of the root from which the starches were derived.

Nevertheless, the investigation has clearly shown that the varieties from which Samples Nos 14 and 16 were prepared may be regarded as highly satisfactory. These two starches returned the best analytical figures and gave the best dextrinisation results.

It seems hardly likely that the slightly inferior analytical figures given by Nos. 13 and 18, indicating slightly less thorough washing, can explain their inferior dextrinising power, and it is probable that the drying of the starch is at fault. On the other hand, however, the sample which by analytical figures and appearance had quite obviously received the poorest washing treatment, Sample No. 15, gave a distinctly bad result under dextrinisation. In this case, however, poor washing may have been accompanied by faulty drying.

It would be of great interest to prepare improved samples from the roots which yielded Sample No. 15, and also Nos. 18 and 13, and to re-determine their value for dextrinisation. It is possible that under satisfactory preparation the variety which yielded No. 15 may give a starch equal in quality to No. 14. (This proved to be the case for No. 15 and also for Nos. 18 and 13—see report on the second batch of samples.)

All the present samples suffered from the defect of lumpiness, which must be remedied if the starch is to compete with the top grade material. The great demand for starch at the present time is for dextrine making, and for this purpose the highest grade is required, which must be an even fine powder free from lumps. For some other purposes, such as certain types of adhesives and textile dressings, the makers will accept lumpy starch at a correspondingly lower price, but to be a first-class all-purpose starch fineness of the powder is essential.

REPORT ON SECOND BATCH OF SAMPLES

This batch consisted of 15 samples of starch prepared under the close supervision of the Agricultural Chemist at the Government Farm, Agege, by a further developed process. They represented ten varieties of cassava, including further preparations of five of the six varieties which formed the first batch of samples. The washing of one variety, C997B, considered as probably the best local variety, had been varied to give five samples representing degrees of thoroughness in washing.

It was desired to submit the samples to dextrinisation tests in order to determine differences in quality due to variety and to observe the effect on quality of the amount of washing.

The description and analyses of the samples furnished by the Agricultural Chemist are given in the following table :

No.	Variety.	Number of Washings.	Moisture, per cent., expressed on moist starch.	Ash, per cent., expressed on moisture-free starch.	Protein, per cent., expressed on moisture-free starch.
51	C 50	6	16·9	0·048	0·029
52	C 860 E	6	16·5	0·075	0·036
53	C 975 A	6	14·7	0·107	0·036
54	C 1146 B	6	15·1	0·035	0·029
55	CH 28	6	18·6	0·065	0·025
56	CH 50	6	17·4	0·045	0·044
57	CH 128	6	15·6	0·062	0·090
58	Ogunjobi I	6	18·8	0·091	0·111
59	Ogunjobi III	6	18·7	0·091	0·102
60	C 997 B	1 (2nd batch)	15·9	0·124	0·112
61	„	2 („ „)	15·8	0·131	0·111
62	„	3 (1st „)	18·2	0·137	0·116
63	„	6 („ „)	16·3	0·072	0·079
64	„	6 (2nd „)	15·6	0·104	0·064
65	Recovered starch	—	15·3	0·116	0·083

Results of Examination

Appearance.—All the 15 samples had a good white colour. No. 59 was rather creamy white and the darkest of the set. Nos. 58 and 60 (one washing) were better than No. 59, but a trifle below the others.

Nos. 51 and 53 were of fine texture, while all the others were more or less lumpy.

No. 51 was the most attractive in appearance, while No. 59 the least.

Dextrinisation.—Each sample, after being finely ground, was subjected to the dextrinisation test (see p. 267), with the following results.

All the 15 samples readily dextrinised, yielding dextrines that varied in colour from cream to buff. They were soluble in cold water, except for a slight turbidity, and were free from starch.

No distinction could be made between the samples in respect of dextrinising property as all were satisfactory, and the differences were of minor importance.

Trade Test.—The samples were submitted to a firm of dextrine makers, who ground the starches and carried out dextrinisation tests, their report being as follows:

"The 15 samples of Nigerian Cassava starches have been carefully examined here, and they appear, without exception, to be of excellent quality. Nos. 60 (one washing) and 61 (two washings) are quite up to the average.

"Starch of this quality could, in our opinion, be used practically for any purpose for which tapioca starch is suitable.

"It was, of course, necessary to grind the samples, and it would be better if that could be done at the source, but this does not offer an insuperable difficulty."

Remarks

1. *General.*—All the samples are of good quality apart from lumpiness, and have good dextrinising properties. It is not possible to differentiate between the varieties on this basis, as they are practically equal.

The 15 starches had all been well washed and dried and represent highly satisfactory starch. It is realised that they were prepared by the Agricultural Chemist and that native production may not readily reach such a standard. The method of preparation, judging from the results, is successful, and it is to be hoped that the technique can be taught to native producers. One point may be stressed, and that is that overheating in the process of drying the starch is fatal to dextrinisation, although lumpiness and some specks may be accepted. It is therefore reassuring to observe that the method of drying is well understood at Agege since the 15 samples prepared there were all properly dried.

It is to be noted that in this batch the varieties Ogunjobi I, CH 128 and C 997B have yielded starch of excellent quality. These varieties in the first batch of samples were inferior through faulty preparation.

2. *Fineness.*—The best grades of cassava starch, particularly Java tapioca, have always been marketed in very finely-pulverised form, and fineness of grinding is necessary for dextrine making as well as for other purposes. Since the material has been available in this condition many dextrine makers and other users of cassava starch are not equipped with plant for fine grinding, and hence to these firms lumpy starch would be unacceptable.

However, there are large users who are in a position to grind the starch before use, and in addition there are millers and other grinding firms that could handle lumpy starch and prepare it in a fine state for users without grinding mills. This, of course, entails expense which would be reflected in the price, but such a consideration is of insignificance in the present circumstances.

In view of the urgent demand for supplies a large firm of dextrine makers, who have facilities for grinding and dressing lumpy starch, expressed themselves as willing to accept granular material from Nigeria as there was a lack of suitable pulverising equipment in that country and great difficulties in the way of installation at the present time. It is assumed that the lumpy material which would be exported would be approximately similar to the lumpy samples of the above report.

Although dextrine makers might agree to accept granular cassava starch from Nigeria, the decision rested with the Ministry of Food, since all the imported starch under present emergency conditions is bought by them and allocated to the users, the standard of quality on which the starch is purchased being, *inter alia*, fineness of grinding.

The Ministry (Starch Division) was therefore approached and attention drawn to the possibility of Nigeria supplying this country with increasing quantities of cassava starch of high purity if a finely divided condition was not demanded. In May 1942 the Ministry announced that they were prepared to waive the regulation calling for smooth starch, provided that in other respects the starch conformed to the present specification. The Ministry were greatly interested in the samples of starch prepared at Agege, and wished to encourage the production of commercial quantities of similar quality by the Africans.

The road is therefore cleared for the development of cassava starch production in Nigeria, and a market assured for a product of such quality as is within the range of the present local capabilities. This product can be of high purity, as shown by the above samples, but it lacks the fineness of division required in first-grade starch. This shortcoming, however, can be overcome under the present emergency by carrying out the grinding in this country, but when the conditions of a competitive market are restored it will be necessary for Nigeria to consider the installation of the requisite pulverising equipment, action which is not possible at the present time.

II. Basis of Quality of Cassava Starch

In ordinary commercial practice cassava starch is not sold on chemical analysis, but according to sample. The trade speaks of various grades such as Superfine, Fine, Medium and Common, but there is no precise specification in use for these grades and they must be regarded simply as qualities that are generally recognised by inspection and simple test, the three features concerned being colour, cleanliness and " squeak." With the last-named is bound up texture and fineness of division. When a new line of starch is offered the usual practice is for the consumer to take a few bags and apply the material to his particular purpose, dextrine making, adhesives, textiles, etc., and on the results to decide whether or not the brand of starch in question suits his requirements. Samples or trial bags so submitted are accepted as the standard of future deliveries. Brands of high-grade starch which have established a reputation for reliability are probably used without control testing.

Some consumers apply specific laboratory tests to samples before buying. For example, dextrine makers may carry out dextrinisation tests, or the determination of *p*H values, while adhesive makers and other industrial users may determine gelling power; viscosity is seldom determined.

It has been very difficult to discover the degree of importance attached to acidity or *p*H value by the users of cassava starch. It was, however, repeatedly stated by consumers, merchants and brokers that for dextrine and adhesive manufacture cassava starch must have a low acidity though no uniform interpretation of this requirement could be found. Each manufacturer knows his own requirements and follows his own standards.

The features which constitute quality and the simple tests usually made by consumers are as follows :

Colour.—The colour must be a good white, and by practice the grade of colour is judged with fair constancy.

Cleanliness.—This means freedom from coloured specks. " Specky " starch always remains as such, since dressing cannot remove fine specks. Larger particles of extraneous matter are not usually encountered.

" *Squeak.*"—Under the pressure of a knife, such as a large table knife, pressed through a small heap of the starch, a well-washed and finely divided sample emits a " squeak," whereas a less clean and more lumpy starch does not. This test was correlated at the Imperial Institute with the results of chemical analysis of a number of samples and found to be a reliable indication of purity.

This test is of more significance than may at first be apparent. A well-washed starch is a pure starch, and after drying it is easily pulverised, readily yielding a fine powder. An impure starch is imperfectly washed and contains non-starchy matter, protein and fibre, and after drying does not pulverise so easily as a clean starch. The difference in condition of the particles is the cause of the difference in behaviour when the sample is pressed.

The analysis carried out at the Imperial Institute consisted of determinations of moisture, ash, protein and fibre by the usual methods and, in some cases, the dextrinisation test described later (p. 267). A study of the results yielded by this fuller analysis in correlation with the standard of quality assigned to the samples by dextrine makers enables quality to be interpreted in terms of analytical results. In the table (on p. 266) the results of examination of the present samples from Nigeria, together with the figures for other samples of cassava starch examined at the Imperial Institute are given and the commercial quality stated.

Consideration of the table shows clearly the connection between quality and analytical figures. On these figures the Imperial Institute has suggested maximum limits, and taking all available evidence into consideration these limits appear to be a safe standard to adopt for the superfine grade. Examining the figures in detail it is seen that all the 15 samples of the Nigerian Second Batch fall within these limits, likewise Nos. 14 and 16, but No. 17, described as " medium " quality, fails in respect of its protein content, while Nos. 13, 18 and 15 fail either in respect of protein or fibre. No. 18 is an example of the value of determining fibre content, since although the ash and protein figures are passable the fibre content shows the starch to be inferior. The limit suggested for ash may be generous, but this figure is recommended as we have had a sample (No. 3) of superfine grade with low protein and fibre content but an ash figure of 0·24 per cent. Provided the protein and fibre figures are satisfactory this seemingly liberal allowance of ash is not detrimental.

CASSAVA STARCHES
(*Percentages*)

Sample.	Moisture.	Ash.	Protein.	Fibre.	Dextrine-makers report or remarks.
Nigerian, 1st Batch					
14 (CH 28)	12·2	0·06	0·11	0·05	" Superfine "
16 (Ogunjobi II)	12·2	0·16	0·15	0·05	" Superfine "
17 (CH 50)	12·4	0·18	0·18	0·10	" Medium "
13 (C 997B)	12·2	0·20	0·22	0·05	" Inferior "
18 (CH 128)	12·3	0·20	0·15	0·13	" Inferior "
15 (Ogunjobi I)	12·2	0·24	0·33	0·15	" Bad, unsuitable for dextrine making "
Nigerian, 2nd Batch					
Top-limit figures of the 15 samples	18·7	0·137*	0·116*	—	" Excellent quality "
Range of all samples of fair appearance examined at the I. I.	10·9	0·03	0·01	0·0	Minimum
	16·2	0·6	0·6	0·4	Maximum
Typical individual samples					
1. Sample of very low quality	14·8	0·94	1·42	0·3	Not included in range given above
2. Low quality	12·0	0·52	0·31	0·3	Only fit for feeding stuffs
3. First quality	12·0	0·24	0·09	0·05	Superfine, i.e. highest grade
4. High class brand	11·3	0·04	0·01	0·025	ditto
Maximum limits for highest grade	12·5	0·25	0·15	0·05	Figures suggested by the I.I.

* Oven-dry basis.

With regard to moisture content the figures for the 15 samples of the Nigerian Second Batch are high, considerably higher than those for the earlier six samples. It is desirable to keep the moisture within the limit of 12·5 per cent. as suggested if the starch is to rank as a first-class product.

It will be seen that the high-class brand of cassava starch, which is a well-known superfine grade from Java, returned an exceptionally good analysis. Sample No. 16 gave analytical figures which were clearly inferior to those of that starch. Nevertheless the dextrine-maker pronounced No. 16 on appearance and by a dextrinisation test to be superfine grade. This dextrine-maker, in common with many others, in the ordinary way never sees an analysis of the starch he buys, judging on appearance or dextrinisation test only. Hence the figures for No. 16 can be accepted as satisfactory. The figures for No. 16, though below those of the high-class brand starch, are of course greatly superior to those of a low-grade cassava starch.

Although No. 16 has been put into the same grade as the high-class brand starch, it is conceivable that on a well-supplied, competitive market, conditions which do not exist to-day in the United Kingdom, the latter starch would be easier to sell than No. 16.

To sum up, a cassava starch must be well washed and of low acidity, and if it is well washed it will have a good colour free from specks and it will easily pulverise to a finely divided powder. Simple inspection for these three points, colour, cleanliness and "squeak," gives with practice a good indication of quality. To be on surer ground an analysis for moisture, ash, protein and fibre may be made, and if the results are within the limits suggested in the above table, it is evidence that the sample belongs to the highest grade and will be suitable for those commercial purposes for which such starches are demanded.

The investigations at the Imperial Institute have shown that starches of first grade analytical figures have invariably given excellent results on dextrinisation, but the theory of "vitrification" has been advanced to explain some cases of bad dextrinisation, an explanation which attributes the cause to a mainly physical condition of the starch, at any rate not to a lack of purity, and brought about by faulty drying. This theory has not been investigated, and until a decision concerning it has been obtained, it is advisable to cover the possibility of "vitrification" by supplementing the above analysis with an occasional dextrinisation test, which is carried out at the Imperial Institute as described below.

The analytical limits quoted are for the top grade of cassava starch. Lower grade starches having lower analytical figures are also readily saleable. No. 15 in the first batch of samples from Nigeria, although unsuitable for dextrine making, would be saleable for other purposes at a few shillings per cwt. less than the top grade.

Dextrinisation Test employed in foregoing Investigation.—To 10 gms. of the cassava starch in a mortar add 0·2 cc. of dilute hydrochloric acid (3·4 per cent. w/w) and 0·2 cc. of dilute nitric acid (3·0 per cent. w/w), and rub with the pestle until thoroughly mixed. Transfer the mixture to a beaker and allow it to mature overnight, uncovered, in the open laboratory. Then spread the mixture in a thin layer on filter paper, and dry it in an oven at 35° C. ± 3° for 3 hours. Transfer the paper and mixture to an oven at 155° C. ± 5°, and roast for 1 hour. If the dextrinisation has been successful there should be a distinct colour change; the product should be from cream or pale buff to pale yellow in colour. It should be soluble in water, either on shaking in the cold or on warming slightly. The most significant feature is the reaction with iodine, for which test 2 or 3 drops of iodine solution (1 per cent.) are added to a solution of the dextrinised product (about 10 per cent. in strength) and the colours produced by the falling drops observed. A well dextrinised product will show a reddish-brown colour, while unconverted starch gives a blue colour, and intermediate results correspond to a mixture of these two colours, in other words, no trace of blue in the colour indicates complete conversion, while varying amounts of blue in the colour represent lesser degrees of dextrinisation.

APPENDIX

The Production of Cassava Starch as a Nigerian Village Industry

By K. T. Hartley, M.A., B.Sc.,
Senior Agricultural Chemist, Nigeria

The process of extraction of cassava starch is extremely simple, and is well known to the natives of various parts of Nigeria. It consists of the following stages:

1. Washing and peeling the roots.
2. Reducing the peeled roots to pulp.
3. Washing the starch out of the pulped roots.
4. Washing, drying and grinding the starch.

A good sample of starch is obtained only if the stages are carried out quite separately and under clean conditions. As might be expected, the material offered for sale when the trade first started varied greatly in quality and many samples were extremely fibrous and discoloured.

The Chemical Section of the Agricultural Department therefore set to work to organise the native process so that it would give a standard and satisfactory product. As a preliminary, a number of statements made by African producers to Extension Work staff were tested out under laboratory conditions. It was alleged that good starch could not be prepared:

(*a*) from old roots;
(*b*) if the starch were dried in the sun;
(*c*) with anything but perfectly clean water.

But these proved to be excuses for poor starch and not explanations of it. Starch of apparently the same quality was produced from roots varying in age from 9 to 30 months and whether dried in the sun or the shade. It was quite remarkable how little deleterious effect seemed to be caused by a slight muddiness of the washing water. On the other hand, water stained with organic matter is definitely unsuitable, as the colour is absorbed by the starch.

In these trials and in all preparations made by us or under our supervision the product was crunchy (i.e. " squeaked "). This was the case even when the pulped roots were left to ferment for some time as may be done by Africans. On the other hand, some African prepared samples have no " squeak," and many have very little.

After this preliminary work and the inspection of the work of various African producers, an experimental " factory " was set up at Moor Plantation to make starch on a scale comparable with what might be expected in a single village. The appliances used were as far as possible purely African and where imported ones had to be used they were such as are commonly available in the country.

A site was chosen and cleared near a stream of water of average quality. Two " buildings " were put up: one consisted merely of a rough roof of palm leaves on poles to provide shade for the workers; the other was a properly thatched building with thatched walls on three sides and provided with racks to carry drying trays for the starch.

Five production units were set up under the roof, each unit being intended for two girls. The chief items were native pots, and a diagram of the layout of these in one unit will facilitate a description of the process.

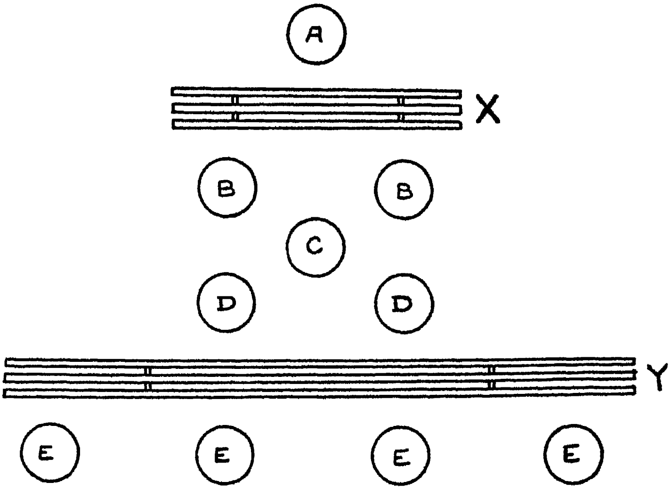

FIG. 1—ARRANGEMENT OF POTS USED IN PREPARING STARCH.
(*For explanation, see text.*)

All pots were the same size, native made, about 18 in. diameter at the top and 2 ft. deep. These were made by the local potters at the same price as the standard shape, which has a comparatively narrow mouth and is therefore less suitable for the present purpose. They were cement washed to prevent flaking, but would probably have been better without this treatment as the cement soon rubbed off and so flaking took place.

The roots as they come from the field are washed in pot A. Clean water is not necessary for this, and when the process was working wash water from partly-washed starch was used here. The two girls working this unit then sit on seat X and peel the roots, putting the roots into pots B and throwing peelings and trimmings into a basket. The wastage at this stage is considerable, as all coloured material must be removed. This necessitates thick peelings and deep trimming at any damaged points on the roots.

When the day's supply of roots is ready (about 70 lb. unpeeled roots per girl) the girls wash their hands and arms and proceed to grate the roots into pots D. The grater consists of one side of a petrol tin punched with nail holes and mounted on a plank about 4 ft. long and 10 in. wide. The girl steadies the grater by sitting on it on seat Y. (Both seats consist of two or three palm ribs mounted on forked sticks.) Some water is placed in pots D to start with, and the amount is increased by washings of the grater, as may be necessary. Clean water is stored in pot C.

When all the roots have been pulped the girls clean their hands of pulp, turn about on the seat, and tie a piece of stout calico over two of pots E. Two sticks are placed parallel to each other over the cloth, and a small, closely woven basket about 1 ft. diameter and 6 in. deep is placed on top. The pulp in pots D is stirred up and diluted with water if necessary and some is ladled out with a small calabash to fill the basket already referred to. Most of the liquid runs through into pots E, carrying with it the starch. The pulp remaining in the basket is washed two or three times with water until the liquid running through is no longer noticeably milky. Finally the pulp is squeezed dry in handfuls which are thrown into a waste basket and the extraction is continued with a further batch of pulp. This part of the process is very slow. The material in pots E is left to stand over-night.

The following morning, before work is started on a new batch of roots, the water is poured out of pots E where solid blocks of starch will be found at the bottom. One of the other E pots is filled with clean water. The prepared starch is dug out in lumps which are scraped top and bottom. There is usually discoloured organic matter on the top, and a layer containing sand and other particles on the bottom. The scraped lumps are dropped into the clean water and stirred up with it. The scrapings are worked up again with the new day's batch or the combined scrapings from several units are dealt with again together.

The washed starch settles quite rapidly and is ready for a second washing at the close of this, the second, day's work. It is thus washed twice on the second day. It is washed twice again on the third day, and on the morning of the fourth day it is baled out as dry as possible and left to dry over-night in the pot. All the washing pots are kept covered with mat covers. When several units are in action all the starch produced on any one day is combined at the first washing and is subsequently treated as one batch.

On the fifth day the starch is dug out in lumps and put out to dry on trays consisting of native grass mats tied to bamboo frames. The trays are arranged on racks in the sun during the day and are put away in the building already referred to at night or if rain threatens. Drying takes three or four days of normal dry season weather. It can be hastened by breaking up the lumps, but this is inadvisable before the last day, otherwise loss through the material of the trays is considerable. It is very easy to get the starch dirty during the drying process and experience showed that it was practically essential to cover the trays with muslin.

When dry and ready for bagging the lumps of starch readily break down by hand into a mixture of powder and small lumps about the size of a pea at the largest. No satisfactory method of further grinding has been devised. Machinery appears to be essential. The starch can be ground to pass a 100-mesh sieve by rubbing between a bottle and a smooth board, but the process is extremely slow and laborious and probably does not produce a material which the trade would regard as " finely ground."

With the five units worked by eight girls and two men, the " factory " could deal with 6 cwts. of cassava roots a day for five days a week, Saturday being restricted to clearing up, bagging and so forth. This does not, of course, include harvesting and transport of the cassava. The yield of starch is about 10 per cent. of the weight of roots.

The process has been demonstrated to the Departmental Extension staff and to other Africans—producers and buyers. They have been impressed by the closeness with which it follows native practice and it is hoped that they have also appreciated the improvements in organisation and cleanliness.

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The Leaf Hopper, *Thamnotettix argentata* Evans, a Vector of Tobacco Yellow Dwarf. By G. A. H. Helson. *J. Coun. Sci. Industr. Res., Aust.*, 1942, **15**, 175-184.

Insect Pests of Cigar-Type Tobaccos in the Southern Districts. By F. S. Chamberlain and A. H. Madden. *Circ. No.* 639, *U.S. Dep. Agric.* Pp. 54, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1942.) Price 15 cents.

Control of Insects Attacking Stored Tobacco and Tobacco Products. By W. D. Reed and J. P. Vinzant. *Circ. No.* 635, *U.S. Dep. Agric.* Pp. 40, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1942.)

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The Cultivation of Medicinal Plants. *Bull. No.* 121, *Minist. Agric. Lond.* Pp. 27, 9½ × 6. (London: H.M. Stationery Office, 1942.) Price 6*d.*

Papaya Production in the United States. By H. P. Traub, T. R. Robinson and H. E. Stevens. *Circ. No.* 633, *U.S. Dep. Agric.* Pp. 36, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1942.) Price 10 cents.

Farmacognosia de las quinas, quinina y antipalúdicos sintéticos. By F. Fernandez de Soto. *Ion, Madrid,* 1942, **2,** 516-528. Pharmacology of cinchona alkaloids, quinine and synthetic antimalarials.

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Cellulosic Plastics. By C. Diamond. *Reps. Appl. Chem., Soc. Chem. Ind., Lond.,* 1941, 290-298.

Dextrines from Potato, Maize, Rice and Other Minor Starches. By R. L. Datta and Prafulla Kumar Chatterjee. *Bull. No.* 98, *Dep. Industr. Bengal.* Pp. 14, 9¾ × 6½. (Alipore, Bengal: Superintendent, Government Printing, 1942.)

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Annual Report of the Veterinary Department, Nyasaland, for 1941. Pp. 8, 8 × 6½. (Zomba: Government Printer, 1942.)

Annual Report of the Department of Veterinary Science and Animal Husbandry, Tanganyika Territory, 1941. Part I. Pp. 9, 13 × 8. (Dar es Salaam: Government Printer, 1942.) Price Sh. 1/-. Deals with routine activities and normal progress of the Department.

Keeping Livestock Healthy. Yearbook of Agriculture, U.S. Department of Agriculture. Pp. 1276, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1942.) Price $1.75.

Studies on Carotene in Relation to Animal Nutrition. 3. Stability of Carotene in Plant Material with Special Reference to Hay Making and Storage. 4. Carotene Balance Experiments with Cows and Bullocks. By P. A. Seshan and K. C. Sen. *J. Agric. Sci.,* 1942, **32,** 275-285, 286-293.

Artificial Insemination and Community Breeding of Cattle. By J. Anderson. *E. Afr. Agric. J.,* 1942, **8,** 2-8.

Copper Deficiency of Cattle and the Fatal Termination "Falling Disease." By H. W. Bennetts, R. Harley and S. T. Evans. *J. Dep. Agric. W. Aust.,* 1942, **19,** 96-104.

Gascoyne Stock Route Poison Plants. By C. A. Gardner. *J. Dep. Agric. W. Aust.,* 1942, **19,** 84-95. A survey undertaken to discover the cause of stock poisoning on this cattle route.

Grass Sickness in Horses. A Review of the Present Knowledge of the Disease, with particular Reference to the Nature of the Causal Agent. By J. Russell Greig. *Trans. Highld. Agric. Soc. Scot.,* 1942, **54,** 1-27.

Mange in Horses, Cattle and Sheep. By A. E. Cameron. *Publ. No.* 734, *Dep. Agric. Canada.* Pp. 14, 9¾ × 6½. (Ottawa: Department of Agriculture, 1942.)

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The Growth-Rates of Local and Cross-Bred Sheep. By M. H. French. *E. Afr. Agric. J.,* 1942, **8,** 24-25.

"Stringy" Wool and Copper Deficiency in Western Australia. By H. W. Bennets. *J. Dep. Agric. W. Aust.,* 1942, **19,** No. 1, 7-13.

Pig-Feeding Experiment using Dried *Clostridium* Residue. By R. Braude and A. S. Foot. *J. Agric. Sci.,* 1942, **32,** 324-329.

Vitamin "A" in Swine Feeding. By W. D. Albright and L. D. Fraser. *Publ. No.* 736, *Dep. Agric. Canada.* Pp. 16, 9¼ × 6¼. (Ottawa: Department of Agriculture, 1942.)

The Effect of Season on the Fattening of Swine at Various Stages of Growth. By G. Dunlop and A. West. *Emp. J. Exp. Agric.*, 1942, **10**, 161-168.

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Report on the Fisheries of New South Wales for year ended June 30, 1941. Pp. 9, 13 × 8. (Sydney: Government Printer, 1942.) Price 10*d*.

Notes on the Application of Refrigeration to the Australian Fishing Industry. *Circ. No.* 4-P, *Coun. Sci. Industr. Res. Aust.* Pp. 18, 9 × 6. (Melbourne: Government Printer, 1942.)

Some Problems of the Cold Storage of Fish. By C. L. Cutting. *Food Manuf.*, 1942, **17**, 219-221.

The Tuna, *Kishinoella tonggol* Bleeker in Australia. By D. L. Serventy. *J. Coun. Sci. Industr. Res. Aust.*, 1942, **15**, No. 2, 101-112.

The Biology and Cultivation of Oysters in Australia. 2. A Note on the Calcium Content of Some East Australian Waters. 3. Biochemistry of the Proximate Constituents. By G. Humphrey. *Pamphl. No.* 111, *Coun. Sci. Industr. Res. Aust.* Pp. 40, 9½ × 6. (Melbourne: Government Printer, 1941.)

FORESTRY

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Report of the Colonial Forest Resources Development Department, April 1, 1940, to March 31, 1942. Pp. 7, 13 × 8. (London: Colonial Forest Resources Development Department, 1942.)

Annual Progress Report on the Forest Administration in Ajmer-Merwara for the year 1940-41. Pp. 47, 9½ × 6½. (Delhi: Manager of Publications, 1942.) Price Rs. 8 As.14.

Annual Progress Report on Forest Administration in the Province of Bihar for the year 1939-40. By L. R. Sabharwal. Pp. 53, 13 × 8. (Patna, Bihar: Superintendent Government Printing, 1941.) Price Re. 1 As. 10.

Annual Progress Report on Forest Administration in the Province of Orissa for 1940-41. Pp. 82, 10 × 7. (Cuttack, Orissa: Superintendent, Government Press, 1942.) Price Rs. 3 As. 13.

Annual Report of the Director of Forestry, State Forest Service, New Zealand, for the year ended March 31, 1941. Pp. 50, 13 × 8. (Wellington: Government Printer, 1941.) Price 1*s*. 3*d*.

Annual Report of the Forestry Department, Nyasaland, for 1941. Pp. 15, 8 × 6½. (Zomba: Government Printer, 1942.) Price 1*s*.

Annual Report of the Forest Department, Uganda, for 1941. Pp. 8, 9½ × 6. (Entebbe: Government Printer, 1942.) Price Sh. 1/-.

Eucalyptus saligna and Soil Reclamation. By H. A. Read. *J. S. Afr. For. Assoc.*, 1941, No. 7, 50-52.

A Note on the Distribution of *Chlorophora excelsa* in Uganda. By A. S. Thomas. *Emp. For. J.*, 1942, **21**, No. 1, 42-43.

Phlœm Necrosis. A Virus Disease of the American Elm. By R. U. Swingle. *Circ. No.* 640, *U.S. Dep. Agric.* Pp., 8, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1942.) Price 5 cents.

The Problem of the Pure Teak Plantation. By M. V. Laurie and A. L.

Griffith. *Indian For. Rec.* (*New Series*) *Silvic.*, 1942, **5,** No. 1. Pp. 121 + 8 plates, 9½ × 7½. (Delhi: Manager of Publications, 1942.) Price Rs. 3 As. 10.

Insect Attack in Japanese Bamboo Poles. By R. C. Fisher. *Emp. For. J.*, 1942, **21,** No. 1, 48. Identity of insects discussed and means of destroying them.

Timber

British Standard Grading Rules for Structural Timber for Purposes where the Stresses in Timber are Known. *Brit. Stand. No.* 940, Part 2, 1942. Pp. 35, 8½ × 5½. (London: British Standards Institution, 1942.) Price 2*s*.

Principal Decays of British Hardwoods. By K. St. G. Cartwright and W. P. K. Findlay. *Ann. Appl. Biol.*, 1942, **29,** No. 3, 219-253.

Note on Indian Timbers for Aircraft and Gliders. By V. D. Limaye. *Indian For. Rec.* (*New Series*) *Utiliz.*, 1942, **2,** No. 7. Pp. 12, 9½ × 7½. (Delhi: Manager of Publications, 1942.) Price As. 4.

The Thermal Conductivity of Indian Timbers. Part 1. Variation of Conductivity with Density in the Air-Dry Condition at Ordinary Temperature. By D. Narayanamurti and V. Ranganathan. *Indian For. Rec.* (*New Series*) *Utiliz.*, 1942, **2,** No. 6, Pp. 17, 9½ × 7½. (Delhi: Manager of Publications, 1942.) Price As. 9.

A Short Note on Wood Preservation for Users in India. By D. Narayanamurti. *Indian For. Bull. No.* 110 (*New Series*), *Utiliz.*, 1941. Pp. 22, 9½ × 7½. (Delhi: Manager of Publications, 1942.) Price As. 12.

Cheap and Simple Types of Tanks for the Treatment of Timber by the Dipping, Steeping or Open Tank Process. By D. Narayanamurti. *Indian For. Bull. No.* 111 (*New Series*), *Utiliz.*, 1941. Pp. 3 + 6 plates, 9½ × 7½. (Delhi: Manager of Publications, 1942.) Price As. 6.

Nyasaland Indigenous Timbers. By J. B. Clements. *Nyasald. Agric. Quart. J.*, 1942, **2,** No. 3, 6-19.

The Properties and Uses of South African Kiaat (*Pterocarpus angolensis*) Timber. By M. H. Scott. *J. S. Afr. For. Assoc.*, 1941, No. 7, 61-66.

The Relationship between Modulus of Rupture and Weight in South African Grown Pine Timber. By J. M. Turnbull. *J. S. Afr. For. Assoc.*, 1941, No. 7, 67-77.

Machinery and Related Characteristics of Southern Hardwoods. By E. M. Davis. *Tech. Bull. No.* 824, *U.S. Dep. Agric.* Pp. 42, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1942.) Price 15 cents.

The Preservation of Timber, with Special Reference to Rhodesia. By R. H. Finlay. *Proc. Trans. Rhod. Sci. Assoc.*, 1942, **39,** 103-112.

Wood Waste Utilisation. I. The Chemical Utilisation of Wood Waste. By W. G. Campbell. II. The Utilisation of Sawdust and Shavings. By P. Harris. *For. Absts.*, 1942, **4,** No. 2, 71-77.

Some Physical Properties of Modern Cabinet Woods. 2. Screw-Holding Power. 3. Directional and Volume Shrinkage. By E. S. Harrar. *Trop. Woods*, 1942, No. 70, 1-15; No. 71, 26-33.

Resins

A Study on the Development of Gurjan Oil Industry in Bengal. Part I. By A. Karim, M. A. Azam and M. Waliullah. *Bull. No.* 90, *Dep. Industr. Bengal.* Pp. 11, 9¾ × 6. (Alipore, Bengal: Superintendent, Government Printing, 1941.) An account of the nature and uses of the oleo-resin from *Dipterocarpus* spp.

Tanning Materials

Controlling Factors in the Extraction of Vegetable Tanning Materials. By F. L. Hilbert. *J. Amer. Leath. Chem. Assoc.*, 1942, **37,** 240-249.

IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 20

(July to September 1942)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

GENERAL

Agriculture and Animal Husbandry in India, 1938-39 (published 1941). Section 6—Entomology, pp. 151-161, contains information on the control of the rice hispa with pyrethrin; lures such as citral, citronella oil or lemongrass not effective for fruit flies; control of woolly aphis by nicotine sprays in the United Provinces; lead arsenate more effective than nicotine against the codling moth in Baluchistan; pyrethrum powder satisfactory against *Oxyptilus regulus* caterpillars in Mysore vineyards; tobacco extracts against the pea aphis in Bombay; tobacco and sulphur dusting on chillies thrips at Coimbatore; tobacco decoction spray in Travancore; dusting with pyrethrum and sulphur gave encouraging results against the cardamom thrips in Mysore and in Travancore the pest was controlled by tobacco decoction; of a number of materials tested against stored grain pests it was found that mixing the grain with acorns yielded promising results.

Report of the Cornell Agricultural Experiment Station, 1940, pp. 126-137. (*R.A.E.*, 1942, **30**, A, Pt. 7, 360.) Rotenone dust most effective insecticide tested against the Mexican bean beetle, and rotenone spray more effective than nicotine sulphate in summer oil emulsion; toxicity of nicotine administered internally is little affected by the form in which it is administered; in tests against eggs of *Cydia pomonella* rapeseed, coconut, sunflower-seed, cottonseed and raw linseed oils not less toxic than petroleum oil and castor oil; pine oil more effective carrier for nicotine than petroleum oil.

Insect and other Pests in 1941. By A. E. Cameron. *Trans. Highld. Agric. Soc., Scot.*, 1942, **54**, 108-136. Oil-pyrethrum insecticide useful for disinfecting larders against *Dermestes lardarius*; pyrethrum or derris in kerosene for controlling *Piophila casei*; value of pyrethrum spray in mills and warehouses against insects of stored products.

The Effects of several Spray Materials on the Apparent Photosynthesis of the Greenhouse Rose. By D. C. Kiplinger and A. Laurie. *Bimthly. Bull. No.* 210, *Ohio Agric. Exp. Sta.*, 1941, 105-119. (*R.A.E.*, 1942, **30**, A, Pt. 6, 288.) Materials tested included combinations of rotenone and oil, rotenone and glycerol, rotenone, pyrethrin and oil, pyrethrum and soap.

Tentative Spray Schedule for the Control of Insects on Michigan Roses. By E. I. McDaniel. *Mich. Agric. Exp. Sta., Quart. Bull.*, 1941, **23**, 275-280. (*Amer. Chem. Absts.*, 1942, **36**, No. 13, 3899.) Pyrethrum, nicotine or rotenone recommended for sucking insects.

The Yellows Disease of Lettuce and Endive. By M. B. Linn. *Bull. No.* 742, *N.Y. Agric. Exp. Sta.*, 1940. (*Amer. Chem. Absts.*, 1942, **36**, No. 10, 2985.) Dusting with pyrethrum-sulphur dust or rotenone-sulphur dust gave significant decreases in the yellows disease, which is spread by leaf-hoppers.

Insect Pests of Cigar-Type Tobaccos in Southern Districts. By F. S. Chamberlain and A. H. Madden. *Circ. No.* 639, *U.S. Dep. Agric.* Flea-beetles satisfactorily controlled by a dust containing 1 per cent. rotenone derived from derris or cube root; tobacco thrips satisfactorily controlled by nicotine sulphate and soap spray.

Dusting for Control of Strawberry Weevil (*Anthonomus signatus* Say.) in 1941. By J. M. Amos and J. H. Beacher. *Bull. St. Brd. Agric., Delaware*, 1941, **31**, No. 4, 23-36. Rotenone-dust and pyrocide not very effective. (*Amer. Chem. Absts.* 1942, **36**, No. 12, 3617.)

Insect Investigations during 1940. Flea Beetles and Thrips. By A. W. Morrill and D. S. Lacroix. *Bull. No.* 444, *Connecticut Agric. Exp. Sta.*, 1941, pp. 278-281. Potato flea beetle and the tobacco thrips well controlled by pyrethrum dusts; cube dust effective against flea beetles but not so effective against thrips.

Pea Aphid and Pea Weevil Control. By H. Glasgow. *Canning Trade*, 1940, **62**, No. 49, 7-8. (*Amer. Chem. Absts.*, 1942, **36**, No. 13, 3897.) Nicotine treatment effective; rotenone dusts slightly erratic in their effect but normally give satisfactory control.

Life History and Control of the Sugar-beet Webworm (*Loxostege sticticalis*). By J. H. Pepper and E. Hastings. *Bull. No.* 389, *Montana Agric. Exp. Sta.*, 1941. (*Amer. Chem. Absts.*, 1942, **36**, No. 10, 2985.) Pyrethrum and rotenone gave satisfactory control if used at first signs of infestation.

Insect Pests. *Agric. Gaz. N.S.W.*, 1941, **52**, Pt. 7, 363-368. (*R.A.E.*, 1942, **30**, A, Pt. 6, 280.) Nicotine sulphate spray recommended for controlling the black peach aphid and the red-legged earth mite; a dust containing derris powder and nicotine gave good control of the latter insect.

Some Insect Pests of Military Camps. By C. F. H. Jenkins. *J. Dep. Agric. W. Aust.*, 1942, **19**, 13-37. Kerosene-pyrethrum spray useful against almost all insects mentioned; pyrethrum or derris dusts controls fleas; nicotine sulphate in soap solution useful against the red-backed spider.

Apple Sawfly. *Adv. Leafl. No.* 13, *Minist. Agric. Lond.*, 1942, pp. 2-4. Discusses control measures and merits of nicotine, quassia, derris and lonchocarpus.

The Compatibility of Fruit-drop Chemicals. By K. J. Kadow and S. L. Hopperstead. *Trans. Peninsula Hort. Soc.*, 1941, **55**, in *Bull. St. Brd. Agric., Delaware*, 1941, **31**, No. 4, 32-34. (*Amer. Chem. Absts.*, 1942, **36**, No. 12, 3617.) Gives particulars of certain compounds which appear to be compatible with derris and nicotine.

A Review of some recent Entomological Investigations and Observations. By G. H. Corbett and H. T. Pagden. *Malay Agric. J.*, 1941, **29**, No. 9, 347-375. Nicotine spray gave better control of *Plutella maculipennis* on cabbage than derris or pyrethrum sprays.

Toxicities of Bordeaux Mixture, Pyrethrum and Derris to Clover Leafhoppers. By T. C. Watkins. *J. Econ. Ent.*, 1942, **35**, No. 2, 234.

The Relative Effectiveness of Dust Mixtures against the German Cockroach. By J. E. Dewey. *J. Econ. Ent.*, 1942, **35**, No. 2, 256. Pyrethrum and derris tested.

Insecticides Derived from Plants. By N. E. McIndoo. *J. Econ. Ent.*, 1942, **35**, No. 2, 285.

The Examination of Plants for Insecticidal Constituents. By R. C. Roark. *J. Econ. Ent.*, 1942, **35**, No. 2, 273. A review with suggestions for further work.

Some Deterrent Trials. By H. E. Durham. *Gdnrs'. Chron.*, 1942, **112**, No. 2905, 76. Products of vegetable origin used to deter attacks by birds, mice and certain insects.

Insecticides: Present Demand and Long-term Outlook. By R. C. Roark. *Oil, Paint, Drug Rep.*, 1942, **142**, No. 3, 7, 72.

Relative Toxicity of Insecticides. By J. R. Busvine. *Nature*, 1942, **150**, No. 3798, 208-209. Refers to the advisability of using more than one test species of insect for investigations on toxicity.

(*R.A.E.*, 1942, **30**, B, Pt. 9, 141.) "Thanite," a chemical defined as thiocyanoacetate of a secondary terpene alcohol obtained in the U.S. from Southern pine stated to be as effective as rotenone in household sprays.

Insecticides and Fungicides. By A. L. Efimov and I. A. Kazas. (In Russian.) Moscow, Sel'khozgiz, 1940. (*R.A.E.*, 1942, **30**, Pt. 9, 419.) Insecticides of vegetable origin are referred to.

Common Names of Insects approved by the American Association of Economic Entomologists. By C. W. Muesebeck. *J. Econ. Ent.*, 1942, **35**, No. 1, 83.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Growing Tobacco as a Source of Nicotine. By J. E. McMurtrey, C. W. Bacon and D. Ready. *Tech. Bull. No.* 820, *U.S. Dep. Agric.*, 1942.

New Industries from Nicotine. *Chem. and Met. Engng.*, 1941, **48**, No. 10, 138-139.

Nicotine for Aphids. By B. Smit. *Frmg. S. Afr.*, 1942, **17**, 459-462.

Cabbage Aphids (*Myzus persicæ* and *Brevicoryne brassicæ*). *Agric. Gaz., N.S.W.*, 1942, **53**, 237. Nicotine sulphate for control.

Report of the New Mexico Agricultural Experiment Station for 1939-40, pp. 41-55. (*R.A.E.*, 1942, **30**, A, Pt. 8, 399.) Valeric acid, nicotine sulphate and pine-tar oil mildly attractive with syrup of glycerine and gum tragacanth as bait for adults of the codling moth.

Control of the Boll Weevil on Sea Island Cotton under Florida conditions. By C. S. Rude. *U.S. Dep. Agric., Bur. Entomol. Plant Quarantine* E-566, 1942. Boll weevils and cotton aphids controlled by applications of a dust containing calcium arsenate and nicotine sulphate.

Combatting the Summer Cabbage Fly. By P. N. Galakhov. *Sady i Ogorody* (*U.S.S.R.*), 1941, No. 5, 58-59. (*Amer. Chem. Absts.*, 1942, **36**, No. 12, 3615). Gives results of experiments with anabasine sulphate and nicotine sulphate on the eggs and larvæ of the fly.

Studies of Codling-Moth Cover Sprays in 1941. By H. N. Worthley. *Pennsylvania St. Hort. Assoc. News*, 1942, **19**, 80-87, 89-92. (*Amer. Chem. Absts.*, 1942, **36**, No. 11, 3313.) One or more applications of tank-mixed nicotine bentonite followed by oil-nicotine satisfactory.

A New Control Measure against the Codling Moth. By A. V. Doinikov. *Bull. Plant Prot., U.S.S.R.*, 1940, No. 4, 65-66. (*R.A.E.*, 1942, **30**, A, Pt. 6, 297.) Nicotine sulphate effective.

Factors influencing Codling-Moth Control. By W. S. Hough. *Proc. Virginia St. Hort. Soc.*, 1942, **30**, No. 1, 114-118. (*Amer. Chem. Absts.*, 1942, **36**, No. 13, 3899.) Under Virginia conditions most satisfactory spray combination lead arsenate, summer oil emulsion and nicotine sulphate.

Possibility of controlling Oriental Fruit Moth with Insecticides. By R. W. Dean and E. H. Smith. *N.Y. St. Hort. Soc. Proc.*, 1942, **87**, 200-202. (*Amer. Chem. Absts.*, 1942, **36**, No. 13, 3899.) Fixed nicotine spray did not give satisfactory control—objectionable residue left on fruit.

False Yellowhead Fireworm, *Sparganothis sulfureana* Clem. By C. S. Beckwith. *Proc. Amer. Cranberry Growers' Assoc.*, 1942, **72**, 23-25. (*Amer. Chem. Absts.*, 1942, **36**, No. 13, 3900.) Spraying with lead arsenate and nicotine gives sufficient control to prevent browning of cranberry foliage, but not enough to prevent a damaging second generation of worms.

The Control of the Lodgepole Needle Miner. By J. S. Yuill. *J. Econ. Ent.*, 1942, **35**, 16-20. (*Amer. Chem. Absts.*, 1942, **36**, No. 13, 3900.) Lead arsenate and nicotine sulphate controlled *Recurvaria milleri*.

I. Experiments on combatting the Spring Worm, *Sparganothis pilleriana* Schiff. II. Experiments on Winter Extermination of the Spring Worm and the Curly Mite. By O. Jancke. *Z. Pflanzenkrankh. Pflanzenschutz*, 1940,

50, 309-314; *Chem. Zentr.*, 1940, 1348. (*Amer. Chem. Absts.*, 1942, **36,** No. 15, 4659.) Nicotine failed completely.

Potato Disease Control Studies on the Maryland Eastern Shore. By R. A. Jehle. *Bull. No.* 433, *Maryland Agric. Exp. Sta.*, 1940. (*Amer. Chem. Absts.*, 1942, **36,** No. 15, 4659-4660.) Addition of nicotine sulphate to Bordeaux mixture, or to dusting mixture recommended for controlling aphids.

Insect Pests. *Agric. Gaz. N.S.W.*, 1942, **53,** Pt. 6, 285-287. Red-legged earth mite controlled by nicotine sulphate—white oil emulsion spray; carrot aphids controlled by nicotine sulphate and lead arsenate spray or dust.

Resultados de la experimentacion de tratamientos contra las plagas animales del algodonero. By H. Munoz Pinochet and S. Tessi Seitun. *Bol. No.* 75, *Mens. Junta Nac. Algodon*, 1941, pp. 580-587. (*R.A.E.*, 1942, **30,** A, Pt. 6, 314.) *Aphis gossypii* and *Gargaphia torresi* on cotton controlled by nicotine sulphate.

A "Delousing Leg Band" for Chickens. By C. M. Hamilton. *Vet. Med.*, 1942, **37,** No. 4, 178. (*Exp. Sta. Rec.*, 1942, **87,** No. 1, 93.) Medicated leg band containing nicotine sulphate among other compounds.

Orchard Sprays and the White Apple Leafhopper. By W. J. Schoene. *J. Econ. Ent.*, 1942, **35,** No. 2, 220. Nicotine found ovicidal.

Studies of Nicotine as an Insect Fumigant. By H. H. Richardson and A. H. Casanges. *J. Econ. Ent.*, 1942, **35,** No. 2, 242.

Nicotine Poisoning in Horticultural Occupations. By H. Symanski. *Anztl. Sachverst. Ztg.*, 1940, **66,** 57. (*Amer. Chem. Absts.*, 1942, **36,** No. 12, 3620.)

Limits of Inflammability and Ignition Temperature of Nicotine in Air. By G. W. Jones, G. S. Scott and W. E. Miller. *Rep. Invest. No.* 3640, *U.S. Bur. Mines*, 1942.

Others

The Alkaloids of American Hellebore and their Toxicity to the American Cockroach. By E. J. Seiferle, J. B. Jones and C. H. Richardson. *J. Econ. Ent.*, 1942, **35,** No. 1, 34.

House Flies. By J. W. Evans. *Tasm. J. Agric.*, 1942, **13,** 76-78. Use of hellebore in destroying maggots in manure referred to.

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

Report of the Chief of the Bureau of Animal Industry, U.S. Department of Agriculture, for the year ending June 30, 1941. (*R.A.E.*, 1942, **30,** A, Pt. 9, 131.) Reference to the continuation of the experiments on the effectiveness in the control of *Hypoderma lineatum* on cattle of washes of derris and cube.

Insecticides containing Rotenone and Suitable for Spraying Plants. By L. E. Smith and L. J. Haller. U.S. Pat. No. 2,271,350. *Amer. Chem. Absts.*, 1942, **36,** No. 12, 3620.

A Note on *Derris* and other Rotenone-bearing Vegetable Insecticides, their Occurrence and Possibilities of Cultivation in India. By T. P. Ghose. *Indian For. Leafl. No.* 20 (*Chem.*), *For. Res. Inst.*, 1942.

Further Studies on the Effect of several Spray Materials on the apparent Photosynthesis of the Greenhouse Rose. By M. T. Possum and A. Laurie. *Bimthly. Bull. No.* 214, *Ohio Agric. Exp. Sta.*, 1942, 42-52. (*Amer. Chem. Absts.*, 1942, **36,** No. 13, 3900.) Of various sprays tested mannitan monolaurate alone, or combined with rotenone showed the least effect on CO_2 assimilation by the plants.

Fruitworm Control. *Mississippi Farm. Res.*, 1941, No. 12, 7. (*Exp. Sta. Rec.*, 1942, **86**, No. 6, 811.) Rotenone ineffective against the tomato fruitworm.

Production of Tomatoes for Canning and Manufacturing. By J. H. Beattie, W. R. Beattie and S. P. Doolittle. *Frms. Bull. No.* 1901, *U.S. Dep. Agric.*, 1942, p. 24. For controlling flea beetles on plants in the seed bed or newly set plants a dust mixture of rotenone and talc is recommended.

Relative Efficiencies of Rotenone-containing Insecticides in the Control of Insects. By F. S. Arant. *51st Ann. Rep. Alabama Agric. Exp. Sta.*, 1941, pp. 42-43. (*Amer. Chem. Absts.*, 1942, **36**, No. 5, p. 4659.) Roots of devil's shoestring (*Tephrosia virginiana*) contains from 0·6 to 2·8 per cent. rotenone; mechanical condition of the dust and diluents such as sulphur and hydrated lime markedly affected the efficiency of rotenone dusts for vegetable insects.

The Citrus Bud Mite and Its Control. By A. M. Boyce, R. B. Korsmeier and C. O. Persing. *Calif. Citrograph.*, 1942, **27**, 124-125, 134-140. (*Amer. Chem. Abst.*, 1942, **36**, No. 12, 3616.) The most effective combinations of powdered rotenone-bearing roots with ¾-1 per cent. light-medium oil are approximately two-thirds as effective as ⅔ light-medium oil used alone.

Pea Aphid Control with Rotenone-bearing Dusts. By R. L. Janes and H. F. Wilson. *Canner*, 1942, **94**, No. 11, 10-11. (*Amer. Chem. Absts.*, 1942, **36**, No. 13, 3897.)

Use of Dusting Machines in controlling Pea Aphids. By H. F. Wilson. *Canner*, 1942, **94**, No. 16, 24-28. (*Amer. Chem. Absts.*, 1942, **36**, No. 13, 3897.) With rotenone dusts the character of the diluent of great importance.

Bull. No. 405, *Maine Agric. Exp. Sta.*, 1941, p. 411. Rotenone dust gave no noticeable reduction in fruitfly infestations on apples; p. 416, rotenone dusts without wetting and spreading agents effective against the Mexican bean bettles; pp. 421-422, effects of rotenone dusts on pea aphid control; pp. 482-483, the addition of rotenone to copper spray fungicides increased the yields of potatoes.

Plantas ictiotoxicas. Farmacologia da rotenona. By C. F. Corbett. *Monogr. No.* 1, *Fac. Med. Univ. S. Paulo,* 1940. (*R.A.E.*, 1942, **30**, A, Pt. 9, 419.) The pharmacology of rotenone.

A Histological Comparison of the Effects of Certain Drugs on Scabies, as studied in Rodent Infections. By R. M. Gordon and D. R. Seaton. *Ann. Trop. Med. Parasit.*, 1941, **35**, No. 2, 247-268. (*R.A.E.*, 1942, **30**, B, Pt. 7, 118-119.) Rotenone discarded because of severe scrotal dermatitis that it occasionally provokes.

A Preliminary Report on the Chemical Composition of Yam Bean (*Pachyrhizus erosus* Urban), a new Rotenone-bearing Plant. *Kwangsi Agric.*, 1941, **2**, No. 4, 269-280. (*R.A.E.*, 1942, **30**, A, Pt. 9, 418-419.)

A Review of Methods for the Chemical Analysis of Rotenone-bearing Plants. By H. A. Jones. *U.S. Dep. Agric., Bur. Entomol. Plant Quarantine* E-563, 1942. (*Amer. Chem. Absts.*, 1942, **36**, No. 12, 3620. Title only given.)

The Use of Power Sprayers in the Control of Cattle Grubs. By R. W. Wells. *J. Econ. Ent.*, 1942, **35**, No. 1, 112. Rotenone applied.

Studies on Rotenone and other Organic Insecticides for Control of Codling Moth. By S. W. Harman. *J. Econ. Ent.*, 1942, **35**, No. 2, 223.

Rotenone Order M-133 (U.S.A.) amended to allow the use of rotenone-bearing materials as spray, wash or dust for the treatment of cattle grubs. *Soap*, 1942, **18**, No. 7, 113.

U.S. to Get Major Brazilian Products. *Oil, Paint, Drug Rep.*, 1942, **142**, No. 6, 5. During a four-year period the U.S. will buy up to 4,000,000 pounds annually of rotenone from Brazil.

Derris

Annual Report of the East African Agricultural Research Station, Amani, for 1941, p. 4. Refers to experiments on the staking of derris, which have given increased yields of dried roots over unstaked plants.

The Determination of Rotenone in Derris Root. By H. E. Coomber, J. T. Martin and S. H. Harper. *J. Soc. Chem. Ind., Lond.*, 1942, **61**, No. 7, 110-112. *Bull Imp. Inst.*, 1942, **40**, No. 3, 179-185.

Evaluating Protection of Fabrics from Clothes Moths and Carpet-beetle Attack. By R. E. Heal. *J. Econ. Ent.*, 1942, **35**, No. 2, 249. Method described; derris tested.

Laboratory Tests with Insecticides against the Tobacco Flea Beetle. By G. Wene and C. B. Dominick. *J. Econ. Ent.*, 1942, **35**, No. 2, 183. Derris compound much more effective than other insecticides.

Thiocyanate-Derris Dusts for Control of Truck Crop Insects. By H. G. Walker and L. D. Anderson. *J. Econ. Ent.*, 1942, **35**, No. 2, 281.

The Subterranean Grass Caterpillar, *Oxycanus* sp., Chemical Control Investigations, 1940 Season. By L. J. Dumbleton and R. D. Dick. *N.Z. J. Sci. Tech.*, 1941, **22**, No. 6A, 309A-322A. (*R.A.E.*, 1942, **30**, A, Pt. 8, 385.) Derris tested but not very effective.

The Use of Derris and Cube Washes and Dusts in the Control of Cattle Grubs. By R. W. Wells and E. W. Laake. *U.S. Dep. Agric., Bur. Entomol. Plant Quarantine* E-562, 1942. (*Amer. Chem. Absts.*, 1942, **36**, No. 12, 3619.)

Relation of Flea-beetle Control to Control of *Alternia solani* on Tomatoes. By J. W. Heuberger and A. E. Dimond. *Plant Disease Reptr.*, 1941, **25**, 415-418. *Amer. Chem. Abst.*, 1942, **36**, No. 10, 2986. The addition of derris powder to several copper sprays improved the control of early blight on tomatoes.

The Cabbage Moth (*Plutella maculipennis*). *Agric. Gaz. N.S.W.*, 1942, **53**, 236-237. Derris recommended for control.

Bull. No. 400, *Maine Agric. Exp. Sta.*, 1940. (*R.A.E.*, 1942, **30**, A, Pt. 9, 446.) Derris dust not effective against *Rhogoletis pomonella* on blueberries; rotenone almost as effective as calcium arsenate in controlling Mexican bean beetle.

An Experience with Derris Powder. *Frm. Stk-Breed.*, 1942, **56**, No. 2754, 1132. Effect of derris on flea-beetles.

A Sussex Method of Attacking the Flea-Beetle. By L. H. Willett. *Frm. Stk-Breed.*, 1942, **56**, 1279. Describes a satisfactory method of applying derris.

Methods to Combat Ants. *Indian Frmg.*, 1942, **3**, No. 3, 161. Refers to the successful use of derris.

Chronic Toxicity of Derris. By A. M. Ambrose, F. Deeds and J. B. McNaughton. *Industr. Engng. Chem., Industr. Ed.*, 1942, **34**, No. 6, 684-689.

Red Spider on Glasshouse Crops. *Adv. Leafl. No.* 224, *Minist. Agric. Lond.*, 1942, p. 3. Derris sprays for control recommended.

Magpie Moth (*Abraxas grossulariata*). *Adv. Leafl. No.* 65, *Minist. Agric. Lond.*, 1942, p. 2. Spraying or dusting with derris or lonchocarpus recommended for control.

Dry Application of Cube or Derris in Combination with Wettable Sulfur for the Control of Cattle Grubs. By E. W. Laake. *J. Econ. Ent.*, 1942, **35**, No. 1, 112.

Di-nitro-o-cresol and other insecticides as Locust Poisons: Experiments of 1938-39. By M. C. A. Nolte. *Sci. Bull. No.* 232, *Un. S. Afr. Drp. Agric.*, 1941. (*Amer. Chem. Absts.*, 1942, **36**, No. 12, 3617.) Derris root powder ineffective as bait.

Lonchocarpus

Apple Sprays—Dormant through Petal-Fall. By H. M. Steiner. *Pennsylvania St. Hort. Assoc. News*, 1942, **19**, 93-95, 97. (*Amer. Chem. Absts.*, 1942, **36**, No. 11, 3313.) Cube gave good results as a delayed dormant spray against the pistol case-bearer; in combination with mannitan monolaurate gave fair control of rosy aphis and -European red mite; cube, wettable sulphur and mannitan monolaurate effective also against the mite.

Others

A Rotenone-bearing Variety of *Tephrosia virginiana* in New Jersey. By J. M. Ginsburg, J. B. Schmitt and T. S. Reid. *J. Econ. Ent.*, 1942, **35**, No. 2, 277.

Rotenone Content, and Inherited Character in the Roots of Devil's Shoestring, *Tephrosia virginiana*. By V. A. Little. *J. Econ. Ent.*, 1942, **35**, No. 1, 54.

Insecticidal Action of *Millettia pachycarpa* Benth. By S. F. Chiu, S. Lin and Y. S. Chiu. *J. Econ. Ent.*, 1942, **35**, No. 1, 80. Considerably toxic to several species of insects.

PYRETHRIN-CONTAINING MATERIALS

Report of the Florida Agricultural Experiment Station, 1938-39. (*R. A.E.*, 1942, **30**, A, Pt. 9, 443.) Certain sprays and dusts of pyrethrum gave promising results against *Leptoglossus phyllopus* on the satsuma orange; pyrethrum gave best control of *Thrips tabaci* on onion sets, and nicotine sulphate also fairly effective.

Methods of Testing Pyrethrum Biologically. By E. A. Parkin. *Nature*, 1942, **149**, 720.

Pyrethrum *vs.* Roaches. Part II. By F. L. Campbell. *Soap*, 1942, **18**, No. 6, 119-127, 141.

Pyrethrum in combatting Insect Pests. By A. G. Terent'ev. *Farmatsiya*, 1940, No. 12, 35-36. (*Amer. Chem. Absts.*, 1942, **36**, No. 10, 2985.)

Control of Insects Attacking Stored Tobacco and Tobacco Products. By W. D. Reed and J. P. Vinzant. *Circ. No.* 635, *U.S. Dep. Agric.*, 1942. Describes the method of application of pyrethrum powder in open warehouses.

Experiments in the Application of Pyrethrum for the Control of certain Ectoparasites of Domestic Animals. By V. I. Kurchatov. *Vestn. Sel.-khoz. Nauk. Vet.*, 1941, No. 2, 97-103. (*R. A.E.*, 1942, **30**, B, Pt. 9, 142.)

The Control of Insects infesting Dried Fruit. By W. Burns Brown and A. E. H. Higgins. *Rep. Dep. Sci. Industr. Res.*, 1942, pp. 21-23. The use of pyrethrum sprays dealt with.

The Control of Flies in Country and Town. By H. G. H. Kearns. *Ann. Appl. Biol.*, 1942, **29**, No. 3, 310-313. Refers to the effectiveness of pyrethrum in highly-refined petroleum oils for rubbing on the skin to protect from midges; pyrethrum sprays for dealing with cluster flies and flies in towns.

The Beet Leafhopper (*Eutettix tenellus*). By W. C. Cook. *Frms'. Bull. No.* 1886, *U.S. Dep. Agric.*, 1942, p. 19. Mixture of pyrethrum extract in diesel fuel oil applied in atomised form is effective.

The Leaf-eating Ladybird Beetle (*Epilachna* 28-*punctata*). *Agric. Gaz. N.S.W.*, 1942, **53**, 237-238. Pyrethrum may be used in control.

The Cultivation of Medicinal Plants. *Bull. No.* 121, *Minist. Agric. Lond.* Gives a brief account of pyrethrum.

A Discussion of Researches on the Sugar-cane Froghopper (*Tomaspis saccharina*). By A. Pickles. *Trop. Agric., Trin.*, 1942, **19**, No. 6, 118. Pyrethrum dust following the use of "Cyanogas" is advocated for the control of this pest.

The Quantitative Interaction of Spray Fluid and Active Principle in Determining the Toxicity of a Pyrethrum Preparation to the Argasid Tick *Ornithodorus moubata* Murray. By G. C. Robinson. *Ann. Appl. Biol.*, 1942, **29**, No. 3, 290-300.

Pyrethrum Flowers and Pyrethrum Products in First Hands Frozen by the U.S. War Production Board. *Soap*, 1942, **18**, No. 7, 91.

Allocation of Pyrethrum. Order M-179, U.S. War Production Board. *Soap*, 1942, **18**, No. 7, 121. Complete text of order.

Experimental Malaria Control in a Hyperendemic Tea Garden in Upper Assam by the Use of Pyrocide 20 as an Insecticidal Spray. *J. Malar. Inst. India*, 1941, **4**, No. 1, 35-55. (*R. A.E.*, 1942, **30**, B, Pt. 7, 101-102.)

Report of the Committee on Bed-Bug Infestation, 1935-1940, Medical Research Council, 1942, p. 21. Need for further research regarding use of pyrethrum in the control of the pest.

Effect of Storage Conditions on the Toxicity of Pyrethrum Extract. By Z. K. Bogatova. *Bull. Plant Prot. U.S.S.R.*, 1941, No. 1, 71-75. (*R.A.E.*, 1942, **30**, A, Pt. 8, 378.)

The Preparation of Insecticidal Aerosols by the Use of Liquefied Gases. By L. D. Goodhue and W. N. Sullivan. *U.S. Dep. Agric., Bur. Entomol. Plant Quarantine* ET-190. An effective aerosol for insect control comprises a solution of pyrethrum oleo-resin and refined sesame oil in dichlorodifluoromethane. Other suitable solvents mentioned and suitable apparatus described.

Toxicity to Adult Mosquitoes of Aerosols Produced by Spraying Solution of Insecticides in Liquefied Gas. By W. N. Sullivan, L. D. Goodhue and J. H. Fales. *J. Econ. Ent.*, 1942, **35**, No. 1, 49. Dichlorodifluoromethane used with pyrethrins and sesame oil.

Effect of Sesamin and related Compounds on the Insecticidal Action of Pyrethrum on Houseflies. By H. L. Haller, F. B. LaForge and W. N. Sullivan. *J. Econ. Ent.*, 1942, **35**, No. 2, 247.

The Effects of Pyrethrins on Certain Mammals. By C. S. Leonard. *J. Econ. Ent.*, 1942, **35**, No. 2, 261.

Pyrethrum. By N. V. Tzitzin. Moscow, Selkhozgiz, 1941. (*R.A.E.*, 1942, **30**, A, Pt. 9, 454.) Cultivation and harvesting in the Soviet Union, preparation of dusts, suspensions, extracts, etc., given.

Dalmatian Pyrethrum. By N. V. Tzitzin. Moscow, Moskovsk, Rabochu, 1941. (*R.A.E.*, 1942, **30**, A, Pt. 9, 454.) Booklet intended for use of workers on collective farms in the Moscow region.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Composition of Geraniol for Japanese Beetle Bait. By H. A. Jones and H. L. Haller. *News Edit., Amer. Chem. Soc.*, 1941, **19**, 683-685. (*R.A.E.*, 1942, **30**, A, Pt. 6, 288.)

Kernels of *Thevetia neriifolia* Juss., a potent Insecticide. By M. C. Cherian and S. Ramacharandran. *Curr. Sci.*, 1941, **10**, No. 8, 365-366. (*R.A.E.*, 1942, **30**, Pt. 6, 303.)

Insecticidal and Piscicidal Plants of India. By R. N. Chopra, R. L. Badhwar and S. L. Nayar. *J. Bombay Nat. Hist. Soc.*, 1941, **42**, No. 4, 854-902. (*Exp. Sta. Rec.*, 1942, **87**, No. 1, 86.) Title only.

BOOK REVIEWS

Books for review should be addressed to " The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7

THE POISON PLANTS OF NEW SOUTH WALES. Compiled under direction of the Poison Plants Committee of New South Wales by Evelyn Hurst, B.Sc. Agr. Pp. xiv + 498, 10 × 7. (Sydney, N.S.W., 1942.)

This compilation, which provides a convenient and comprehensive work of reference to the poisonous plants of New South Wales, is particularly valuable as much of the information it contains had not hitherto been generally accessible. In preparing the work Miss Hurst has used not only published accounts, but also material contained on the files of the National Herbarium, the New South Wales Department of Agriculture, the Glenfield Veterinary Research Station, and the Department of Pharmacy, Sydney University, including, for example, reference to the hitherto unpublished work on Duboisia and other Australian alkaloidal plants undertaken since the outbreak of war. The publication will no doubt be generally appreciated by research workers and those concerned with the management of stock, both in New South Wales and in other States of the Commonwealth. Its appearance will also be welcomed by all those in other countries interested in the subject, particularly as the plants dealt with are not exclusively Australian, but include many introduced from other countries for economic purposes, as ornamental plants, or occurring as weeds.

The work is published by and under the authority of the Poison Plants Committee of the University of Sydney and the New South Wales Department of Agriculture, a body which has been in existence since 1927 and which had decided that a compilation of all previous work on poisonous plants was required. Several bodies and individuals have been concerned in various aspects of the Committee's work, including the preparation of the present volume, as is acknowledged in the preface. Revision of the manuscript and publication details have been in the hands of a small sub-committee, of whom Mr. R. H. Anderson, Chief Botanist of the National Herbarium, has acted as editor. An appreciative reference may also be made to the generosity of certain financial institutions which have assisted towards the costs of publication.

The work is presented primarily as a record of existing information, and little attempt has been made to examine this information critically. A few of the early and obviously incorrect botanical identifications have been amended, but most of the data have been presented as originally recorded. Further work will doubtless lead to more exact knowledge and to the ultimate revision of some particulars which must stand for the present. The plants included appear alphabetically in families under their botanical names; the families are dealt with in the general order of Engler and Prantl. It is noted, incidentally, that the local popular names of the various plants, which are recorded where available, are by no means always the same as are in use in other countries.

Data regarding each individual species is usually introduced with a botanical description; this is omitted with less important plants. A note as regards distribution follows, the country of origin of introductions is recorded. The rest of the information concerning each species is arranged under a series of sub-headings, included as appropriate, e.g. general references, animals affected, symptoms, poisonous principles, part of the plant causing poisoning, conditions under which plant is poisonous, feeding experiments. Such questions as the criteria for determining, and conditions affecting, the toxicity of plants; the diagnosis of, and treatment of stock suffering from, plant poisoning; and the toxic constituents of plants are discussed in the introduction. Suspected plants, as well as those known to be poisonous, are included.

A number of botanical plates of some of the more interesting plants are provided. There is a very extensive bibliography to the quotations cited in the text, and this, incidentally, brings home the great debt we owe to J. H. Maiden for his work on the poisonous plants and weeds of Australia—there are well over 100 references to his papers, dating from 1888 to 1922. Useful glossaries of botanical and medical terms are given and there is a very full combined index to botanical and common names. All concerned in the production of this volume may be congratulated on having performed a valuable and useful service.

MODERN SYNTHETIC RUBBERS. By Harry Barron, Ph.D., B.Sc., A.I.C., A.I.R.I. Pp. viii + 274, 8½ × 5½. (London: Chapman & Hall, Ltd., 1942.) Price 25*s*.

In the preface to this book the author draws attention to the fact that "oddly enough, neither the Germans nor the Americans have so far published any books on the subject" [of synthetic rubbers]. But there is surely nothing odd in this. The subject is still too much in the development stage to justify the investigator summarising his findings in a text-book; he is usually too much concerned with the new problems that keep arising to find time to write up the old ones. And although others may compile a useful survey of what has already been published, as indeed Dr. Barron has done, the really satisfactory treatise on synthetic rubber must still await the leisure of some original researcher.

In his attempt to give the information in "as palatable a form as possible," Dr. Barron has often overstepped the mark and the result in some cases savours more of the newspaper article than the scientific treatise. Moreover, he is too enthusiastic a supporter of synthetic rubber to give a fair picture of the relationship between the natural and the artificial products. He apologises in advance for any errors and omissions in the book, due to the difficult circumstances under which it was written, but in a work of this kind accuracy should be the first consideration and surely it would have been fairer to the reader to have delayed publication until the numerous mistakes which mar the book had been corrected.

Having said thus much in criticism of the book it must be acknowledged that the discerning reader will find much of value in it. The author has combed the literature very thoroughly and most of the facts are duly documented, the references being given at the close of each chapter.

The book is divided into three parts. The first gives a general account of natural rubber and synthetic rubber-like materials and discusses the economics of synthetic elastic materials. Part II deals with the chemical and physical background, including terminology, an historical outline, chemical behaviour and structure of natural rubber, raw materials (alcohol, acetylene and petroleum), polymerisation, copolymerisation and emulsion polymerisation. In the chapter on terminology the author puts forward a simple system of classifying rubber and rubber-like materials, in which he suggests the term " elastene " for materials which are based on olefines and are virtually saturated, such as polyisobutylene, polythene, A.X.F., and butyl rubbers. The choice of the name " elastene " is a little unfortunate as the almost identical word " elasteine " has already been used for a patented French rubber substitute made by the treatment of copals with oleic acid.

The last part of the book discusses the technology of the different types of synthetic rubber arranged according to the author's simplified system under elastomers (S.K.B., Bunas, Perbunan, Hycar o.r., Chemigum and Neoprene), elastenes, thioplasts and ethenoid elastics.

AIDS TO THE ANALYSIS OF FOOD AND DRUGS. By J. R. Nicholls, D.Sc., F.I.C. Sixth Edition. Pp. vii + 424, 6½ × 4. (London: Baillière, Tindall & Cox, 1942.) Price 10s.

This book, which for so many years has been associated with the familiar names of Moor and Partridge, now appears in the sixth edition under the authorship of Dr. J. R. Nicholls, of the Government Laboratory, who was responsible for the revision of the previous one. During the eight years since the publication of the fifth edition, the scope of the work of the analyst engaged on the examination of food and drugs has been considerably extended. This has necessitated the enlargement of this book which has grown from 322 to 424 pages. The increase has been caused by the extension of almost all sections as well as by the inclusion of sections not previously dealt with. The revision is a timely one as since 1934, when the previous edition was published, the Food and Drugs Act, 1938, has come into force and five Addenda to the British Pharmacopoeia have been issued. The necessary alterations pursuant upon these have been introduced in this new edition. Reference is also made to those Emergency Orders dealing with food which involve a question of principle or which are of more than transitory importance. The arrangement of the material follows that of previous editions. This book will continue to be of great help and value to all analytical chemists who are engaged upon the examination of food and drugs.

INDUSTRIAL WASTE TREATMENT PRACTICE. By E. F. Eldridge. Pp. xi + 401, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1942.) Price 35s.

In 1938 the author undertook the collection of data and information relating to the design and operation of plant for the treatment of industrial liquid wastes. What Mr. Eldridge terms "a brief sketch" of the material collected appeared in September of that year as *Bulletin 82 of the Engineering Experiment Station, Michigan State College*, of which institution he is a Research Associate. The reception accorded to the *Bulletin* was encouraging, and suggested there was a need for the fuller account of the subject which is now provided. In this volume the matter forming the original publication has been expanded and some new material included. Much of the information in the work is derived from the author's own experience of industrial waste disposal; for the rest recourse has been had to published accounts as is duly acknowledged.

The work, which relates in particular to conditions that obtain in the United States, opens with a brief introduction in which attention is directed to the very large problems that arise in connection with the disposal of industrial liquid wastes. There is a discussion in the first part of the book of more general questions: stream pollution, the characteristics of industrial wastes, and standard sewage treatment methods and the plant employed which are usually applicable to these liquids. Approaching three-quarters of the text is taken up by separate chapters devoted to considerations affecting the wastes of individual industries, e.g. sugar beet factories, milk products factories, canning factories, pulp and paper mills, and slaughter houses. The several chapters are mostly supported by short bibliographies.

The book is completed by an account of the treatment of combined industrial waste and domestic sewage, and of methods of analysis. A large number of diagrams and tables are provided in the text.

This volume should prove to be a useful introduction to the methods practised in the United States, and it is hoped will be followed by a more extended survey of practice in other countries.

THE NATIONAL PAINT DICTIONARY. By Jeffrey R. Stewart, F.A.I.C. Second Edition. Pp. 224, 12 × 9. (Washington, D.C.: Stewart Research Laboratory, 1942.) Price $7.50.

This work is described on the title page as "a handy reference volume for chemists, production managers, purchasing agents, formulators, technologists, salesmen, advanced painting contractors, distributors and all those engaged either directly or indirectly in the manufacture, distribution, consumption or application of paint and allied products." The dictionary itself occupies some 140 pages and contains definitions of terms, including trade names, and information regarding chemicals, raw materials, methods of analysis, equipment and apparatus used in the industries covered. There are numerous illustrations, mainly of apparatus. In a supplement to the dictionary are given a wide range of data in tabular form, such as physical and chemical properties of raw materials, solubilities, conversion tables, fire extinguishers and so on.

On the whole the data given are reliable and the book should prove of great value to those in any way interested in the materials dealt with. It may be suggested, however, that in preparing a further edition the author should add an experienced economic botanist to the panel of helpers and advisers mentioned in his preface, for it is in this direction that, in common with most books of this kind, the present one is weakest. As evidence of the need for such expert revision the following examples may be quoted: balata gum is not chicle (p. 20); balm of gilead is not the same as Canada balsam (p. 21), which, however, is correctly described as a true turpentine from *Abies balsamea* in the article on turpentine on p. 125; Irish moss is a small red seaweed not "kelp, a large brown seaweed" (p. 72); and jelutong is quite different from the copal, Pontianak gum (p. 104).

MINERAL RESOURCES

ARTICLE

THE MINERAL RESOURCES OF NORTHERN RHODESIA

By T. Deans, M.A., F.G.S.,
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It is perhaps not generally realised that Northern Rhodesia has been the leading mineral producer in the Colonial Empire since 1937, and second only in importance to the Union of South Africa among all African countries. Her rise to this position has been remarkably rapid, the value of her mineral output having increased tenfold in less than ten years, and has been due primarily to the opening up of great copper mines. The latter, which also yield a large amount of cobalt, are grouped in a small area known as the Copperbelt, and together with the Broken Hill lead-zinc-vanadium mine make the country the leading base metal producer in Africa.

The development of the country dates back to 1890, when Lewanika, King of the Barotse, granted to the British South Africa Company a mineral concession over the whole of his dominions, which embraced most of the western half of modern Northern Rhodesia. No doubt Lewanika knew of the existence of copper ore and iron ore in his territories, for both metals had been smelted there for generations, but eight years elapsed before the first prospectors entered the country, and the formal agreement confirming the British South Africa Company's concession was not signed until 1900. The early prospectors soon discovered copper ore, lead and zinc ores, coal, and small gold deposits. By 1924, when the country became a Crown Colony, minerals to the value of some £3,000,000 had been produced, and by the beginning of 1940 the total value of mineral production had risen to £66,000,000.

The systematic manner in which Northern Rhodesia has been prospected and geologically surveyed since 1925 is probably unique. Exclusive prospecting licences covering almost the whole country, except the Barotseland Native Reserve, were granted to certain companies with strong financial backing who undertook to spend substantial sums on prospecting each year. Thorough geological surveying was made the basis of this work, with the result that the country has been geologically mapped in far greater detail than any other area of comparable size in tropical Africa. The adoption of this policy was crowned with success in the Copperbelt, where it was found that certain leached or low-grade outcrops of copper ore changed at shallow depths into rich sulphide ores eminently suitable for concentration by flotation, and that these ore bodies were confined to one geological horizon. The ore-bearing horizon was mapped in detail, favourable sites for drilling were located, and in a few years enormous reserves of ore were proved. Elsewhere in the country, however, no spectacular mineral discoveries were made. By 1939 the surveying and prospecting of most of the country had been completed, and now practically the whole of the territory in respect of which the British South Africa Company holds the mineral rights has again been thrown open to public prospecting. As yet, however, the results of this extensive geological survey and prospecting work have not been made public except in the form of brief summary reports, and so only a very incomplete account can be given of the mineral resources of the country.

A thick mantle of soil covers most of Northern Rhodesia, often 20 to 40 ft. in thickness and even more in certain districts, and over wide areas rock exposures are few and far between. While it is quite possible therefore that other mineral deposits may lie concealed beneath this thick cover, their detection is likely to be exceedingly difficult.

Details of the geology and physiography of the country cannot be given here, but the following generalised table of geological formations and the economic minerals found in them summarises the relations between the deposits mentioned later.

Age.	Formation.	Economic Minerals.
TERTIARY	Kalahari Sands	—
CRETACEOUS	Pebble Beds	—
Post-Karoo Dolerite Sills and Dykes		—
KARROO	Sedimentary Rocks and Lavas	Coal
Pre-Karoo Dolerite Sills and Dykes		—
KATANGA	Kundelungu Series	—
	Basic Igneous Rocks	—
	Younger Granites	—
	Mine Series	Copper and Cobalt
Pre-Katanga Gneissoid Granites		—
MUVA ANKOLE	Broken Hill and Muva Series	Lead, Zinc, Vanadium, Manganese and Graphite.
BASEMENT COMPLEX	Schists and Granite Gneisses	Gold, Mica, Tin and Graphite.

The latest statistics of mineral production and value which it is permissible to publish are shown in the table on p. 297. It should be mentioned that as the values of the base minerals are calculated

NERAL PRODUCTION OF NORTHERN RHODESIA

		Amount.				Value.			
		1937.	1938.	1939.	Total 1906-1939.	1937.	1938.	1939.	Total 1906-1939.
						£	£	£	£
Copper	*tons*	208,178	213,031	211,668	1,280,000*	11,564,571	8,885,629	9,444,371	52,533,424
Cobalt alloy	,,	2,175†	3,697	3,830	12,430	—	—	—	—
Cobalt content	,,	*870*	*1,438*	*1,557*	*5,417*	665,553	1,369,076	1,482,149	4,319,377
Zinc	,,	14,031	10,215	12,695	163,262	332,853	141,701	181,086	2,744,661
Zinc concentrates, etc.	,,	—	—	—	52,778	—	—	—	497,917
Lead	,,	559	273	160	118,706	12,312	4,308	2,660	3,099,330
Vanadium concentrates	,,	1,149	—	—	—	—	—	—	—
Vanadium pentoxide	,,	262	656	674	—	—	—	—	—
Total Vanadium content	,,	*229*	*368*	*382*	*2,349*	132,708	260,816	333,709	2,043,904
Gold	*oz.*	4,228	1,113	4,643	65,432	29,729	7,999	35,147	353,436
Silver	,,	83,861	88,237	80,137	910,985	7,017	7,337	6,844	93,474
Selenium	*lb.*	1,466	4,078	1,277	6,821	513	1,428	447	2,388
Bismuth ore	*tons*	—	—	—	8	—	—	—	3,964
Tin concentrates	,,	8	4	—	28	1,319	501	—	3,946
Mica	*lb.*	8,928	8,620	5,423	93,303	669	649	408	14,475
Iron ore	*tons*	520	205	136	16,023	259	103	68	8,042
Manganese ore	,,	2,341	2,735	2,970	29,294	3,511	3,650	4,455	43,489
Silica rock	,,	—	2,076	3,430	5,506	—	518	857	1,375
Limestone	,,	—	—	46,133	46,133	—	—	20,760	20,760
Total Value						12,751,014	10,683,715	11,512,961	65,783,962

* *Including estimated content of concentrates.*

† *Estimate.*

on the London prices of the refined metals they are in some cases higher than is actually realised in Northern Rhodesia, for the metals exported in some cases require further refining overseas. The assemblage of minerals produced differs for the most part from that of neighbouring countries, except in so far as the copper-cobalt zone extends into the Katanga. The abundant gold, asbestos and chromite of Southern Rhodesia, and the diamonds, radium and tin of the Belgian Congo have no counterparts in Northern Rhodesia. All the important mineral deposits lie close to the railway which runs through the centre of the country, and the outlying regions to the east and west appear to contain little mineral wealth.

Copper and Cobalt

The Copperbelt of Northern Rhodesia is an area some 50 miles long and 25 miles wide along the upper reaches of the Kafue river, close to the Katanga border of the Belgian Congo. Several copper deposits are known outside this area, and these will be mentioned later, but they are insignificant in size when compared with those of the Copperbelt and none of them is now worked. Natives and Arabs had worked copper at Luanshya and Bwana Mkubwa before the arrival of Europeans whose attentions were therefore soon attracted to these deposits. Development work commenced at Bwana Mkubwa in 1903 and ten years later copper concentrates were exported from the mine. The ores, however, were of relatively low grade compared with those mined profitably in the Katanga, and being oxidised proved difficult to treat, so that when thick deposits of clean sulphide ores averaging 4 per cent. of copper were found at Luanshya in 1925 interest in the oxidised ores dwindled. The Luanshya discovery led to the opening up of the Roan Antelope mine, and intense prospecting and geological work followed by drilling soon proved the existence of several enormous sulphide ore bodies in other parts of the Copperbelt. Despite the setback caused by the world economic depression, copper smelting began at Roan Antelope in 1931, at Nkana in 1932, and at Mufulira in 1937.

The ore deposits occur in synclinal areas in the lower beds of the Mine Series and are generally considered to be of epigenetic origin and related to the intrusion of the Younger Granites, although a syngenetic theory of origin has also been advanced. The ores consist of altered shales and felspathic sandstones containing finely disseminated sulphides, principally chalcocite, bornite and chalcopyrite. Most of the deposits consist entirely of sulphides, but the Nchanga ore body contains mixed sulphide and oxidised ores and the Nchanga Extension is largely oxidised ore, malachite being the principal mineral. The ore bodies are sharply defined, gradation into the country rock being exceptional. In form the deposits are beds, usually steeply inclined, and frequently 25 or 30 ft. in thickness, but in the Mufulira mine three beds up to 60 ft. in thickness occur, and in places two coalesce to form a bed 100 ft. thick. The proved reserves of the larger deposits in June 1939 were as follows, taken in order from south to north.

Deposit.	Reserves (*Long tons.*)	Percentage of copper.
Roan Antelope . .	98,595,000	3·43
Baluba . .	19,000,000	3·47
Nkana and Mindola .	101,792,000	3·43
Chambishi . . .	22,000,000	3·46
Mufulira . . .	96,800,000	4·39
Nchanga . . .	128,375,000	4·66*

* *2·53 per cent. present in oxide minerals and 2·13 per cent. in sulphide minerals.*

Further reserves exist which have not yet been proved, and according to the Commissioner of Mines it is probably safe to say that there are at least 750 million tons of high-grade copper ore in the Territory. The proved reserves are greater than those of any other country and the ores are richer than those of the major copper producers, but the annual output of copper is still exceeded by that of the United States, Chile and Canada.

The producing mines are evenly spaced through the Copperbelt, the Roan Antelope mine at Luanshya in the south, the Nkana mine 21 miles to the north-west, the Mufulira mine 20 miles north of Nkana, and Nchanga, where a pilot mill commenced production in 1939, 29 miles north-west of Nkana. Shafts have also been sunk at the Chambishi mine between Nkana and Nchanga. The Bwana Mkubwa deposit at the south-east corner of the Copperbelt was found to have relatively small ore reserves. A special ammonia leaching process was necessary to treat the ore but, although more than 20,000 tons of copper were thus produced between 1926 and 1930, the process was abandoned and the plant has been dismantled. Each mine has its own smelter producing extremely pure blister copper, and at Nkana there is an electrolytic refinery. From the start of smelting in 1931 until the outbreak of the present war, however, copper production was restricted for economic reasons by agreements with the other major copper producers of the world. Between 1936 and 1939 the copper production of the different mines was as follows :

	1936.	1937.	1938.	1939.
Nkana, electrolytic copper .	28,012	30,740	31,367	29,654
Nkana, blister copper	28,092	54,475	49,514	50,126
Roan Antelope, blister copper	56,448	78,349	71,930	68,904
Mufulira, blister copper .	29,782	44,614	60,220	61,669
Nchanga, blister copper .	—	—	—	1,315*
Total	142,334	208,178	213,031	211,668

* *Smelted at Nkana.*

The quantities of ore treated during 1939 and the copper produced, together with their copper contents, are shown in the following table

Mine.	Ore treated.		Copper Recovered.				Copper content.
			Blister.		Electrolytic.		
	Tons.	*% Cu.*	*Tons.*	*% Cu.*	*Tons.*	*% Cu.*	*Tons.*
Nkana	2,469,196	3·53	50,126	99·41	29,654	99·95	79,467
Roan Antelope	2,551,161	3·15	68,904	99·48	-	- -	68,545
Mufulira	1,640,401	4·59	61,669	99·44	—	—	61,321
Nchanga	47,460	4·15	1,315	99·58	—	—	1,310
Total	6,708,218	3·65	182,014	99·45	29,654	99·95	210,643

The Nkana mine also produces important quantities of *cobalt* and is the principal source of this element in the British Empire. The copper ore contains from 0·02 to 0·5 per cent. of cobalt in the form of the sulphide "carrollite", and by special processes involving differential flotation of certain of the ores and treatment of the converter slags a rich cobalt-iron-copper alloy is produced. The latter varies somewhat in composition; that produced in 1939 averaged 40 to 41 per cent. cobalt, 14 to 18 per cent. copper, and the remainder principally iron. It is sent overseas for refining. Other by-products from Nkana of minor importance include *gold*, *silver* and *selenium* which have been recovered from the anode slimes shipped overseas for treatment, and a little gold and silver extracted from enriched blister copper in refineries abroad. Nkana by-products recorded in 1938 and 1939 were as follows:

		1938.	1939.
Cobalt alloy	*tons*	3,697	3,830
Cobalt content	,,	*1,438*	*1,552*
Selenium	*lb.*	4,078	1,277
Gold	*oz.*	420	298
Silver	,,	87,883	57,159

The Mufulira mine also produced precious metals as by-products in 1939 (122½ oz. of gold and 645 oz. of silver).

The sulphur content of the smelter gases, which must be considerable, is not utilised, but should the production of large quantities of sulphuric acid ever become necessary in the Colony, this may prove a valuable source.

North-west of the Copperbelt the rocks of the Mine Series continue into the Belgian Congo where several important copper deposits are worked, differing from those of Rhodesia, however, in that in the main the ores are oxidised and occur at a higher geological horizon. At the Prince Leopold mine at Kipushi, which is one of the most important copper producers in the Congo, however, the copper ore, together with some zinc ore, is obtained from a rich sulphide deposit. This mine is situated only a few hundred yards north of the Rhodesian boundary and its ownership was only settled after a careful re-survey of the frontier. At Kansanshi, 130 miles W.N.W. of Nkana, native copper workings were discovered in 1899 and development work revealed an extensive series of reef-like ore bodies, some carrying gold, and a small smelter was operated there 30 years ago. When last re-examined in 1937, proved reserves of 3,535,000 tons of ore containing 3·65 per cent. copper were blocked out, in addition to more than 6 million tons of probable ore, but the ore is variable and complex and the mine has not been brought into production again. A hundred miles to the west of Broken Hill, between the Kafue river and Mumbwa, more than a dozen small copper deposits were found in 1898 and developed for several years. They proved to be small sulphide replacement deposits formed in brecciated pipes in limestones of the Broken Hill Series, and at one of them, the Sable Antelope mine, a small blast-furnace was built and some matte and high-grade ore was shipped during the last war. Near Mtuga, on the Lunsemfwa river, about 60 miles N.E. of Broken Hill, a series of lenticular chalcopyrite deposits occur in granite gneiss, and reserves of 200,000 tons have been proved. A copper deposit of a type rather unusual in Northern Rhodesia occurs 25 miles west of Lusaka at the King Edward claims. The ore is cupriferous pyrites carrying about 1½ per cent. copper and 20 per cent. of sulphur, and diamond drilling has indicated the existence of more than 5 million tons of ore. Many smaller deposits are known to occur in the Kasempa, Broken Hill and Lusaka districts.

Lead, Zinc and Vanadium

Ore deposits containing these three metals in close association occur in rocks of the Broken Hill Series in the Broken Hill and Lusaka districts. At Broken Hill the Rhodesia Broken Hill Development Co., Ltd., has the most important zinc mine in Africa, and the same company owns the Camarnor vanadium deposit 20 miles to the north-east. Some 56 miles to the south, 10 miles north of Lusaka, is the Star Zinc deposit.

The Broken Hill ore bodies outcropped as a series of kopjes composed of oxidised ores, the largest of these, No. 2 kopje, rising to a height of 90 ft. above the surrounding plain. They are replacement deposits in dolomite and take the form of successive lenses dipping steeply to the north-north-east and pitching to the east-north-east. The larger ore lenses consist of a core of massive sulphides, zinc-blende and galena, enclosed in a shell of oxidised zinc ore, usually about 15 ft. in thickness, composed of hemimorphite, quartz and iron oxides, with lesser amounts of calamine (zinc carbonate), cerussite and vanadium minerals. This " zinc silicate " ore is fine grained and jasperoidal in appearance, the ore minerals being diffused through fine-grained silica, and is very rich, containing from 30 to 55 per cent. of zinc plus lead. The rich vanadium ores surround the zinc silicate ore and are developed largely in the broken ground between the massive oxidised ores and the dolomite, as well as in open fissures. Descloisite, and to a lesser extent vanadinite are the ore minerals, but large quantities of vanadiferous laterite, which frequently averages 3 per cent. vanadium, are also mined at the surface. Vanadium is present in small quantities in the zinc silicate ore but appears to be absent from the sulphide ores. There is only a small amount of silver in the Broken Hill ores (from 1 to 1½ oz. per ton), and there are traces of nickel, cadmium and germanium which have to be eliminated in the electrolytic plant.

During the period which has elapsed since the exploitation of the Broken Hill deposits commenced, many changes have occurred which have reflected changed market conditions and advances in metallurgical practice, first lead, then zinc, and latterly vanadium being the principal products in terms of value. The deposits were discovered in 1902, and in 1906, when the railway reached Broken Hill, a considerable amount of rich zinc ore was mined from the outcrops and exported. Lead production was begun during the war of 1914-18 when four blast furnaces were installed, and output reached a maximum in 1922 when 20,501 tons of lead were produced. Owing to the exhaustion of sulphide ores above the water level, however, the output then declined and smelting for export ceased in 1929, since when only a small quantity of lead has been produced and this only for use in the zinc plant. Electrolytic extraction of zinc began in 1928 and output reached a maximum of 20,730 tons in 1936. Export of vanadium ore began in 1921 and a concentrator and acid leaching plant for the extraction of the vanadium and its conversion to fused vanadium pentoxide (90-95 per cent. V_2O_5) was put into operation in 1930. Production of the fused pentoxide reached a maximum of 674 tons in 1939.

Recent practice at the mine is indicated by the production statistics for 1939, which are the latest officially disclosed. A total of 120,085 tons of ore were mined, consisting of 66,055 tons of zinc ore, 38,250 tons of vanadiferous laterite and 15,780 tons of mixed zinc-vanadium ore. The zinc plant treated 67,936 tons of zinc ore averaging 21·7 per cent. Zn, 4 per cent. Pb, and 0·5 per cent. V, and recovered 7,828 tons of electrolytic zinc (99·98 per cent. Zn) and 4,867 tons of debased zinc (99·27 per cent. Zn). The vanadium plant treated 58,306 tons of vanadium ore averaging 1·41 per cent. V, and recovered 674 tons of fused vanadium pentoxide containing 855,959 lbs. of vanadium. In addition 160 tons of lead were produced from 821 tons of sinter and ores averaging 25 per cent. Pb.

The reserves of ore which could be worked opencast gradually became depleted and an extensive drilling and development programme has been undertaken since 1935 preparatory to exploitation in depth. A pumping shaft has been sunk to a depth of 1,115 ft. and a six-compartment service and hoisting shaft to 600 ft., and work has begun on the 350 ft. and 550 ft. levels. It was found that oxidised ores persisted to a depth of at least 1,000 ft. (much deeper than had been anticipated), and reserves proved at June 26, 1940, were as follows: 2,400,000 tons of oxidised ore carrying 6·7 per cent. Pb, 23·5 per cent. Zn, and 0·83 per cent. V_2O_5, and 1,600,000 tons of sulphide ore containing 23·9 per cent. Pb, 36·7 per cent. Zn, and 18·2 per cent. S. Ore will thus be available for many years, and the production of lead is to be resumed.

The Camarnor deposit occurs in altered dolomite near granite and carries vanadium, lead and zinc, but it has hitherto only been worked on a small scale.

In the Star deposit near Lusaka the ore is willemite occurring in large compact masses in crystalline dolomite close to a granite mass, and containing small amounts of native silver. Reserves of 250,000 tons are said to have been proved, and prior to 1929 several thousand tons of ore averaging 48 per cent. Zn were produced by opencast mining and exported.

Gold

Ancient gold workings containing hundreds of stone mortars and crushing stones have been found in the area east of Lusaka towards the Portuguese border, showing that gold was won in Northern Rhodesia long before Europeans entered the country, but by whom, whether ancient Arabs or Bantu, is not clear. The reefs worked by the ancients appear to have been small and impersistent, and the same can be said of all the deposits which have so far been found. Gold mining recommenced soon after 1900 and production to the beginning of 1940 totalled 65,432 oz., nearly all of which has been obtained from small reef deposits in three localities. Half of this total is from the Luiri area in the Mumbwa district, 80 miles west-north-west of Lusaka, from two mines, the Matala and Dunrobin. Here narrow reefs occur in steeply dipping shear zones in quartz-sericite-schists, containing gold associated with limonite and hæmatite near the outcrops and pyrite and chalcopyrite on the 200 ft. level, pyrite apparently being the gold-carrier. A mill and cyanide plant came into production in 1930 and in 2½ years 21,107 oz. of gold were recovered, the yield averaging about 10 dwts. per ton of ore crushed. After an interval production was resumed in 1936 and in four years 12,075 oz. were recovered, but the yield had fallen to about 3 dwts. per ton, and last year the operating company was wound up voluntarily.

The Jessie mine, 75 miles east-north-east of Lusaka, was opened up about 1919 and worked intermittently until 1937. Several narrow reefs were worked to depths of more than 300 ft. and over 1,000 oz. of gold were produced annually on several occasions. The ore carries bismuth, averaging 1½ per cent. in some cases, and gold recoveries as high as 2 oz. per ton were obtained.

A new mine, the Chakwenga, 90 miles east of Lusaka and 30 miles south of the Great East Road, came into small-scale production in 1940. The deposit was found in 1933, and after being developed systematically for several years down to 230 ft. and 300 ft. levels a two-compartment shaft has been sunk and two Tremain mills installed. In the Petauke district, about 90 miles west of Fort Jameson and 30 miles north of the Great East Road, the Sasare mine was opened up about 1901 and worked for a few years before the war of 1914-18. In 1931 a rich reef up to 30 in. wide was found nearby and worked for a few years as the Sasare West mine, yielding, together with gold won from the old dumps, some 3,000 to 4,000 oz. before the plant was closed in 1938. The Cymric mine, a small property to the south of Fort Jameson and close to the Portuguese border, has only yielded a few ounces of gold. East of the Luangwa valley alluvial gold and some small reefs were found in 1933 around the headwaters of the Msidza stream in the Lundazi district, and small-scale working of alluvials was begun early in 1940. Elsewhere throughout the territory numerous gold occurrences, both reef and alluvial, have been prospected but most of them have proved very unpromising.

Traces of gold are present in the copper ores of Northern Rhodesia, and a few hundred ounces are recorded as having been shipped overseas for recovery in the refinery slimes and enriched blister copper of the Nkana and Mufulira mines. The Nkana mine recorded about 1,000 oz. between 1936 and 1939, and Mufulira mine 122½ oz. in 1939.

Manganese

Although manganese, usually associated with iron, occurs at numerous localities in North Western Rhodesia, frequently as residual deposits which form small kopjes, most of the occurrences appear to be of low-grade and not very extensive. As manganese dioxide is used as a reagent in the Broken Hill zinc plant, however, the ore has been quarried intermittently since 1927 at several localities, mostly in the Broken Hill district. The Lubemba deposit, about 40 miles north of Broken Hill, yielded several thousand tons of ore obtained by screening the rubble contained in the overburden lying round the outcrop. At the Chowa deposits, opened up in 1934 in the same district, there is an almost vertical seam of ore containing up to 40 per cent. of manganese. Production at this property in 1939 totalled 2,970 tons averaging 20 per cent. Mn. In the Copperbelt 877 tons of manganese ore were mined in 1931 for experimental purposes from a deposit at Luano East, a few miles east of Nchanga.

Tin

Only one deposit of tin ore has been worked in Northern Rhodesia, and the few occurrences of this mineral that have been noted in other districts appear to be of no economic value. Near Choma, on the railway line midway between Livingstone and Kafue, the Cassiterides mine was opened up in 1934, and in four years yielded 28 tons of tinstone concentrates. Most of the tinstone has been won from scattered patches of eluvial gravels, in one place 2 ft. in thickness and covered by 2 ft. of overburden, but stanniferous pegmatites have also been opened up nearby. Water supplies have been obtained for working this deposit, but throughout most of this district scarcity of water would make alluvial mining very difficult.

Mica

A few fairly large books of mica have been found in pegmatites at several localities, but the mineral has only been produced commercially in the Mazabuka district. The Sachenga mine, situated 56 miles east of Mazabuka and 45 miles from Kafue, worked since 1925, has been the only producer in recent years. Several pegmatite lenses occurring in a schist belt have been mined, and the mica is dressed and trimmed at the mine. It is good quality ruby muscovite and sheets of large sizes are obtainable.

Coal

Although coalfields were discovered in Northern Rhodesia over 40 years ago, they have never been worked and little has been written about them. The coal used in the copper industry is obtained from the Wankie Colliery in Southern Rhodesia, 600 miles by rail from the copper mines and the reciprocal transport of coal northwards and copper southwards proves economical. Hydro-electric power has also been adopted to supply industrial needs and is being further developed; nevertheless, the coalfields may ultimately become of value to the country, particularly if the present deforestation continues and it becomes more difficult to obtain wood fuel. The coal measures occur at the same geological horizon as those of Wankie (in the Ecca Series of the Karroo System), and so may include seams of good quality, but little information is available about the characteristics of the coals. The best-known field is that in the floor of the Luano rift valley about 55 miles south-east of Broken Hill. Here near the confluence of the Mulungushi and Lunsemfwa rivers the coal measures are 400 ft. in thickness and contain over a hundred coal seams ranging from more than 8 ft. down to a few inches in thickness. Four workable seams totalling 18 ft. 10 in. in thickness have been proved over 700 acres, indicating actual reserves of 22 million tons, as well as large possible reserves.

South of Kafue, coal areas occur in the Lufua and Losito valleys, the coal measures being 300 ft. in thickness. Two seams, 4 ft. and 3 ft. thick, apparently extend over 5 sq. miles, which would indicate probable reserves of 38 million tons, and the possible reserves are large. Other coalfields have been found but appear to be less promising. One lies near the Kafue river north-west of Mumbwa, and another of very small area occurs 22 miles north-north-east of Katumbi at the head of the Luangwa valley close to the Nyasaland border.

Graphite

Graphite occurs in phyllitic shales in the Kundelungu Series of the Copperbelt, and in graphitic schists both in the Broken Hill

Series further south and in the basement rocks of North Eastern Rhodesia, and there are some deposits which might be of economic value. In the Mkushi district, 50 to 60 miles east of Broken Hill, extensive deposits have been found in schists containing up to 30 per cent. of graphite and averaging 21 per cent. Small-scale flotation tests have shown that 70 per cent. of the graphite could be recovered as a product of "amorphous" grade containing 85 per cent. graphite. East of the Luangwa valley flake graphite deposits occur at Njoka about 45 miles north-west of Lundazi, and samples have proved amenable to flotation, but owing to the high cost of transport from this remote locality the deposit has not been worked.

Other Minerals

Bismuth, in the form of bismuthinite, associated with pyrites has been found at several gold prospects, especially at the Jessie gold mine and adjacent claims, and round Mkushi, east of Broken Hill. A few tons of ore have been produced, but since 1920 mining has hardly been profitable.

Tungsten occurs in the district between Lusaka and Kafue, and also 60 miles east of Lusaka, principally as scheelite associated with traces of gold and cassiterite, but apparently not in economic quantities.

Iron ore is of widespread occurrence and small quantities are produced for use in the copper smelters and at the Broken Hill zinc plant. The deposits include high-grade hæmatite and magnetite, but their extent is not known and as it is unlikely that an iron industry will ever be established on an appreciable scale the question of reserves is not likely to be important. The native iron smelters, now practically extinct, usually used the lateritic iron ores which are almost ubiquitous.

In the railway belt *limestone* and *quartzite* are available in abundance for industrial purposes, and since 1938 a pure quartzite has been quarried at the Bwana Mkubwa mine for use in copper smelting.

ABSTRACTS AND NOTES

Obituary—Professor K. N. Moss. With deep regret we have to record the untimely decease on October 20 of Professor Kenneth Neville Moss, O.B.E., M.Sc., M.Inst.Min.E., F.Inst.F., F.G.S., M.Inst.C.E., which has removed from the coal-mining profession an able and most active member in both the academic and practical spheres.

Professor Moss accepted the Chairmanship of the Imperial

Institute Advisory Committee on Coal and Petroleum in 1936 and devoted much energy to the initiation of a scheme for the co-ordination of information on Empire coal resources, particularly in the light of their practical utilisation, an undertaking regrettably interrupted by the outbreak of war.

Born in 1891 at Penns in Warwickshire, he followed a Midland educational career leading to Birmingham University, to which body he returned in 1920 as Assistant Professor of Mining after having gained practical experience in the Cannock Chase, South Yorkshire, and North Staffordshire coalfields. Two years later he was appointed to the Chair of Mining, and in 1935 added further to his work on behalf of the University when he became Dean of the Faculty of Science.

Always intimately associated with the technical and welfare aspects of his profession, Professor Moss contributed much to the published knowledge relating to mining conditions and their effect upon miners' efficiency and health. One of his last public duties was to render valuable national service on the Forster-Brown Committee set up to advise the Government upon the best means of recruitment and training of boys for the coal-mining profession.

The Imperial Institute was but one of many scientific bodies to which he devoted a full measure of active co-operation and energy; they will keenly regret losing the wealth of his experience and knowledge.

J. Brace.—It was with regret that we learned of the recent death at the age of 54 of James Brace, M.M., B.Sc.Econ., LL.B., F.S.S., a former member of the Imperial Institute staff.

Brace entered the Civil Service in 1907, served throughout the war of 1914-18 and was awarded the Military Medal in 1916. On his return to civilian life he studied for and obtained the degree of Bachelor of Science in Economics and in 1922 was appointed statistician to the Imperial Mineral Resources Bureau.

When in 1925 the Bureau and the Institute were amalgamated, Brace became Chief Statistician, in which capacity his responsibilities included the compilation of our Annual Statistical Summary, and the reputation which this publication enjoys is attributable in no small measure to the care he put into its compilation years ago. At the same time, however, he employed much of his leisure in the study of law, with the result that he obtained the London degree of Bachelor of Law and became a barrister of Gray's Inn.

On resigning from the Institute in 1927 he secured an appointment with the Abbey Road Building Society and the following year became Secretary of the Eastbourne Mutual Building Society, of which he was appointed General Manager in 1934, a post he held until his death on September 24, 1942.

Witherite.—The only two barium minerals of industrial and economic importance are barytes (barium sulphate) and witherite (barium carbonate). Of these the former is fairly widely distributed, while the latter is much less commonly found, in fact the only witherite deposits of economic importance in the world occur in England, which country is the sole producer.

In June 1940 the Holmside and South Moor Collieries, Ltd., and the owners of Settlingstones Mines, Ltd., issued jointly a *Handbook on Witherite and its Industrial Uses*, which was reviewed at the time in this BULLETIN (1940, 38, 507-508). The author of this book, Mr. E. W. Muddiman, has recently delivered a lecture to the Newcastle-on-Tyne Section of the Oil and Colour Chemists' Association on the same subject (*J. Oil Col. Chem. Assoc.*, July 1942, 25, 127-140), in which, however, the mining and dressing of witherite are described in greater detail.

Many small mines have been worked in England, but the present production is confined to two only. One of these is in Northumberland, at Settlingstones, near Fourstone, Hexham, and the other in Durham at the Morrison North Pit of the Holmside and South Moor Collieries, Ltd., Annfield Plain.

The Settlingstones Mine, which began its career in the late seventeenth century as a lead producer, occupies the mid-position of a mineral belt, some 5 miles in length, in the Tyne Valley. The first recorded production of witherite from this mine took place in 1872, since when it has been a consistent producer, being for many years, until quite recently, the only source of supply.

The witherite vein is of hydrothermal origin, lying in a much faulted series of sedimentary rocks in the Lower Carboniferous. This series contains the Whin Sill and the witherite vein is worked mainly where it passes through the Whin Sill. Following the vein westwards from the Old Shaft it is found that the lead ore is suddenly cut off at a fault plane near the Winter Shaft and a thin zinc stringer leads on to the witherite vein, which is practically vertical, and on an average about 8 ft. thick.

Mining at Settlingstones has progressed westwards. Two shafts are now in commission from which horizontal levels are driven into the vertical vein at about 60 ft. intervals, and stope supports are fixed into the opposing walls at approximately 4 ft. intervals. The roof is timbered and support is given by old tram rails or steel tubes, concrete being used in some places. Upward or overhand stoping is continued in each working section to within about 8 ft. of the level above, this thickness being left as support until the time comes to abandon the section.

The Holmside and South Moor witherite vein occurs in the Coal Measures. The presence of witherite in this area had been known for about 50 years, but the main vein was found only 10 years ago in a fault fissure near the southern boundary of the coal royalty area, when a heading was being driven from the Low Main seam to the Hutton Seam, about 220 ft. from the surface. The vein has a hade of about 7½° from the vertical and varies in thickness from a few inches up to 16 ft. It has been proved laterally over a length of 550 yds., and to a depth at present of 750 ft. Further development in depth is proceeding.

Stoping is carried out as at Settlingstones. Development was retarded for some time by the presence of water in the lower levels, but this is now pumped to the surface by high-duty centrifugal pumps and is used for washing the run-of-mine witherite in the grading plant. Some high-grade witherite is also obtained from minor veins at the Craghead pit and is taken by lorry to the dressing plant at Annfield Plain.

The dressing processes employed at Settlingstones and Annfield Plain are similar. The crude ore is elevated to the top of the washing plant in the tubs into which it was originally loaded in the mine, and emptied by rotary tippler on to a strong bar screen of 6 in. mesh, the larger lumps being broken by hammers to pass through this screen. From the screen the ore passes to a revolving trommel which has 1⅛ in. round holes, water being sprayed in to give an initial washing and to drive the smaller material out into a hopper at the foot of the main elevator. The oversize witherite is discharged on to a circular revolving table where it is hand-sorted. The waste matter is thrown out, the clean lumps are separated for drying and pulverising, and the rest delivered to a crusher whence it rejoins the smaller material separated off in the trommel. The ore is now raised by bucket elevator to the head of a series of five different trommels, from each of which the oversize, varying from 1 in. to ⅛ in., is delivered to five pulsating jigs of the Hartz type. These remove shale, stone, and other impurities by gravity separation. The clean sized witherite from the first three compartments of each jig is collected into hoppers beneath and passed by belt conveyor to centrifugal driers.

A "middlings" fraction of mixed shale and witherite is discharged from the last compartment of each jig. This is returned by special conveyor belt to crushing rolls, set at ⅛ in., and thence returned to pass through the trommels again.

The undersize witherite from the fifth trommel, passes into a launder and thence to Wilfley concentrating tables. The concentrated witherite thus obtained joins the clean material on the belt from the jigs and the product of the entire process is dried in two Broadbent centrifugal driers and conveyed in tubs to a steam-heated store-house to await disposal.

The clean high-grade witherite which is collected from the picking table is partially dried and passed through a pair of crushing rolls, which reduce it in size to ½ in. and less. The crushed material is dried and pulverised, and finally weighed and bagged in paper-lined tarpaulin bags for the market.

Two grades of pulverised witherite are available as follows:

	I. Normal quality.	II. Finer quality
	Per cent.	*Per cent.*
Retained on 200 B.S. sieve	8–9	0·1
Through 200, on 240 sieve	5–6	0·2
Through 240, on 300 sieve	3–4	0·2
Through 300 mesh sieve	81–82	99·5
	100·0	100·0
Oil absorption	9·0	12·0

(Oil absorption for precipitated $BaCO_3$, 21·0 gms. linseed oil per 100 gm. $BaCO_3$.)

The latter grade conforms to the War Emergency Specification of the B.S.I. for Witherite for Paints (No. 926 of 1940). All the witherite selected for grinding is at least of 93 to 95 per cent. purity.

The other grades of witherite prepared for the market are:

	$BaCO_3$. *Per cent.*
(1) Picked lumps, about 5 in. to 2 in. size	92–94
(2) Nuts, from 1½ in. to ¼ in. size	92–94
(3) Peas, from ⅜ in. to ⅛ in. size	91–93
(4) Fines, from ⅛ in. to 100 mesh	90–92

These grades are sold on a basis of 90 per cent. $BaCO_3$ with *pro rata* adjustments of price according to analysis.

One of the chief economic advantages of witherite over barytes is the great ease with which it can be converted into any other barium salt. Thousands of tons are used annually for the production of barium chloride in the manufacture of which the witherite is mixed with water in large wooden vats, hydrochloric acid (sp. gr. 1·15) is run in, and the whole heated by steam to about 40° C. The crude liquor is purified, filtered, and the filtrate is concentrated and crystallised. Besides being employed in large quantities for the production of blanc fixe, barium chloride is used as a laboratory reagent and as a mordant in the dyeing and printing of textiles.

Blanc fixe (precipitated barium sulphate) is prepared from witherite by precipitation of the iron-free barium chloride liquor, under suitable conditions of temperature and concentration, with dilute sulphuric acid, the precipitate being filtered off and washed carefully. Blanc fixe has many uses. It is employed in the paper industry, in the manufacture of paints, lake colours and printing inks, and as a filler in the rubber industry, and it is also used in medicine.

Barium nitrate may be produced from witherite by direct action with nitric acid, or by double decomposition of hot solutions of barium chloride and sodium nitrate. The barium nitrate in each case is then allowed to crystallise out.

Barium oxide is obtained by roasting finely ground witherite in furnaces with powdered carbon. The peroxide is obtained by heating the oxide to 700° C. in a current of dry air, free of carbon dioxide, and the hydroxide by dissolving the oxide in hot water, and allowing the hydrate to crystallise out. Barium peroxide is used in the manufacture of hydrogen peroxide and large quantities of the hydrate are used in the sugar-beet industry and in the preparation of barium soaps.

Witherite itself finds many uses in industry. In the finely powdered form it is used to prevent the florescence or " scum " on bricks, for the case-hardening of steel, in the purification of brine, and as a water-softener. Barium carbonate is used also in the glass industry and in enamelling. Air-floated witherite is found to be a suitable extender for paints, and in some cases is superior to blanc fixe or barytes. During the past few months the disposal of witherite in all forms has been taken over by the Miscellaneous Chemical Control, and supplies available for the paint industry are now limited.

Nickel in Cuba.—It is reported by Mr. W. L. Batt, Director of Material of the War Production Board in the United States, that the large deposits of low-grade nickeliferous iron ores blanketing the wooded plateaux of north-eastern Cuba are to be treated by a complicated process to yield nickel for armour plate and other special steels which are required for the war effort (*Foreign Commerce Weekly*, 1942, 7, No. 8, pp. 4-5, 37-38).

The nickeliferous iron ores of Cuba have been known and exported to the United States as iron ore for a very long time. There are three important deposits on the north-eastern side of the island. These are at Moa, Mayari and San Felipe. The deposits are similar in type to the nickeliferous iron-ore deposits found in Greece, Celebes and Dutch Borneo.

The Cuban ore is of a lateritic type lying as a mantle over extensive serpentine deposits of which it is a decomposition product. Where conditions have been favourable much of the silica and magnesia from the serpentine has been carried off by weathering, or stream action, leaving a workable iron ore, which contains nearly all the chromium and nickel formerly present in the serpentine.

The ore deposits are found on the summits of fairly high plateaux. Near the surface the material is earthy and dark red in colour. The deposits average 19 ft. in depth, and are estimated to contain about 2,000 million tons of ore. The ore occurs in three main types. It may consist of an earthy mass, varying from dark red to yellow in colour, according to whether hæmatite or limonite predominates in the area ; the ore may occur in small shot-like particles, either concentrated on the surface or embedded lower down in a matrix ; or, thirdly, the shot-like particles may be cemented into boulders.

Mining of this ore is a comparatively simple operation. In general there is little overburden, and the ore can be removed literally from the surface downwards by mechanical means.

The largest deposits in the island occur on the coast at Noa, which lies about 35 miles west of Baracoa and nearly 45 miles east of Nipe Bay. In this place the average thickness of the ore is 18 ft., though in one place it reaches 80 ft. The ore beds cover an area of 70 sq. miles, lying on the northern slope of the range, and extending along the coast to a depth of 10 miles inland. In this area the iron is present mostly in the form of limonite, but near the surface hæmatite and magnetite predominate. The total amount of nickel and cobalt in the ore varies from 0·44 per cent. to 1·28 per cent., averaging 0·8 per cent.

The deposits at Mayari, which lie inland, about 50 miles west of the Moa deposits, have an average depth of about 15 ft. and cover an area of about 40 sq. miles. The ore is fairly uniform and occurs mostly in the form of boulders composed of cemented shot-like particles. Analysis shows it to contain iron in amounts varying from 40-50 per cent.

The Mayari deposit has been extensively worked. The ore yields a nickeliferous pig iron, and a valuable steel known as "Mayari" steel having a low nickel and chromium content is also obtained from it. It is interesting to note that this steel was used in building the bridge over the Mississippi at Memphis, and it has been used in the construction of other bridges.

All the Cuban ores contain a good deal of water, both chemically combined and also held by absorption in the rather porous ore. Prior to shipping the ore to the United States for treatment it is usually run through rotary nodulising kilns which agglomerate the fine ore and drive off the excess moisture. The nodulised product carries about 57 per cent. of iron.

The San Felipe iron ore deposits are in the province of Camaguay, and lie a little to the north of Camaguay City itself. There is a good deal of hard ore at San Felipe, and this necessitates blasting, a practice unnecessary at Moa or Mayari, but the ore, especially if screened, would not need nodulising to improve its physical character for furnace use.

Average analyses of these three ores are given as follows:

	Moa.	Mayari.	San Felipe.
	Per cent.	*Per cent.*	*Per cent.*
Fe	45·67	50·56	44·00
SiO_2	6·26	2·9	1·62
Al_2O_3	10·64	10·24	11·61
Cr	1·96	1·66	1·42
Ni + Co	0·845	0·84	0·76
P	0·008	0·016	0·006
S	0·107	0·20	0·332
H_2O	11·59	10·96	—
Mn	—	—	1·18
CaO, MgO	—	—	1·66

A great deal of experimental work has been done on the Mayari and Moa ores with a view to finding an economic method of extracting the nickel, but only during the last two years has this research resulted in the evolution of a satisfactory process which is now to be set up on a commercial scale on the island.

The early attempts at extracting the nickel were made by a chloridising process, which resulted in a nickel extraction of under 30 per cent. Leaching with ammonia, hydrochloric acid and sulphuric acid was also attempted on an experimental scale, but again results were not good. Finally, satisfactory results were obtained by calcining the ore in an atmosphere of sulphur dioxide. The sulphate mass was leached with water, calcium chloride added, and the nickel chloride finally precipitated as the hydroxide by the addition of burnt lime. This process resulted in the recovery of about 70 per cent. of the nickel but never became a commercial process in peace time.

In view of the greatly augmented demand for nickel at the present time the recovery of nickel from the Cuban ores has recently been undertaken, with government assistance, by the Nicaro Nickel Co., a subsidiary of the Freeport Sulphur Co., which also mines manganese ore in Cuba through another subsidiary, the Cuban-American-Manganese Corporation. Details of the exact process to be employed are not yet published.

After a technical committee representing the Government had approved the research results, the War Production Board authorised a project for the erection on the island of a $20,000,000 plant. The scheme is being financed by the Reconstruction Finance Corporation, and the plant will be operated by the Nicaro Nickel Co. for the Government. The initial work of dredging waterways, laying electric lines and building temporary structures is already under way. Plans have been drawn up not only for essential mining and metallurgical work, but also for the construction of a complete town with hospital, schools and stores. As much labour as possible, both skilled and unskilled, will be Cuban. The ore, instead of being sent away for treatment, will be processed and the nickel extracted near to the original deposits.

Before the war, world consumption of nickel was rapidly increasing. In 1875 the entire world consumption was about 500 tons per annum, early in the 1900's it increased to nearly 10,000 tons, and by the end of the first World War consumption had risen to 50,000 tons. There was a slump in the early 1920's, but by 1929 consumption rose to 68,000 tons and in 1939 just before the present war it totalled 128,000 tons; that is about 6,500 tons more than the actual production in that year. Consumption to-day is still greater and unless strictly controlled would rise to yet further heights. This great demand for nickel would seem to justify the capital expenditure necessary for the recovery of nickel from the low-grade Cuban deposits.

Studies on the Determination of the Particle-size of Finely Divided Materials.—Many methods have been proposed for the evaluation of the particle-size distribution and the specific surface of pulverulent materials, though comparatively few have been sufficiently simple and rapid for their widespread application in industry. A critical study of these latter methods has recently been made by H. E. Schweyer, of Columbia University, in an article in *Industrial and Engineering Chemistry, Analytical Edition*, 1942, 14, No. 8, pp. 622-632.

According to this authority, the methods that have the greatest industrial use employ sedimentation or elutriation principles and, accordingly, base particle-size results on the equivalent settling diameter of the particles. The chief advantages of such methods are simplicity of operation and relatively good precision, provided certain factors are taken into account. As a result of detailed researches, the author concludes that the pipette method is the best he has studied for sedimentation procedures, and, to enable analyses to be carried out more rapidly, he has designed a special pipette for the purpose. It is claimed that this pipette allows an analysis to be made in one-fourth the time required for the Andreasen pipette by utilising shorter distances of fall for the small sizes.

The hydrometer method, when properly calibrated, gives results as precise as the pipette method, and may be used as a rapid control procedure. The results are independent of the size of sedimentation-cylinder diameters greater than 5 cm.

Air elutriation yields results in good agreement with those from sedimentation procedures, provided there is no attrition and the particles are not platy and do not flocculate in suspension.

Using a special technique for size distribution down to 1·25 microns, the author has shown that the Wagner turbidimeter gives good results only for ground sand, silica and certain cements. The data obtained by this method for other materials are unsatisfactory for the determination of specific surface and size distribution, owing to the lack of validity of the empirical conversion of turbidity data to weight concentration.

A comparison of the data obtained by various methods by the author is set out in tabular form, the materials considered being silica, slate, clay, trap rock, limestone, tripoli, coal, galena, mica, talc, pumice and diatoms.

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